Guidelines on
Lifting Appliances

December 2023
(Effective 01 July 2024)

IRCLASS
Indian Register of Shipping

Guidelines

Lifting Appliances

December 2023
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Contents

Sections

Section 1

General

1.1 Application

1.1.1 This document provides requirements for design, construction, and survey of lifting appliances fitted onboard ships and/ or fixed/ floating offshore structures. When certification is carried out for compliance with statutory regulations, any additional requirements stipulated therein will also complied with.

1.1.2 Requirements in this document are applicable to pedestal mounted rotating, heavy lift, gantry, shear leg, stiffleg and “A”-frame type cranes installed aboard vessels and/or fixed/ floating offshore structures.

1.1.3 This document does not address associated handling equipment such as movable or lifting platforms, cargo ramps, passenger and cargo lifts, lift trucks and lifeboat davits.

1.1.4 This document covers the following:

a) Issue of Class Notations to a ship or offshore unit, classed with IRS, one or several class notations, stating that the lifting appliances are under full survey and comply with the requirements.

b) Issue of certification:

• if required, certification of lifting appliances on the basis of international regulations/standards

• if required, certification of lifting appliances in accordance with special national regulations on behalf of National Authorities

c) Issue of Lifting Appliances Register

1.1.5 Attention of Owners and Builders is drawn to the legal provisions and National Regulations of the flag Administration/ Coastal State where the vessel/ offshore unit is registered and those of the competent authorities on operational site are complied with.

1.1.6 This document is published on the understanding that responsibility for control of Safe Working Loads, appliance handling during lifting and setting loads, avoidance of improper weight distributions while lifting a load, securing of the lifting appliance on the vessel or unit when not in use, maintenance of the lifting appliance, and handling and stability of the vessel or unit during operation of the lifting appliance, rest with the Operator/Owner.

1.1.7 Alternate designs using any equivalent recognized international standards may be considered acceptable by IRS.

1.2 Certification of Lifting Appliances

1.2.1 General

1.2.1.1 The certification procedures for lifting appliances are provided in 1.2.2 or 1.2.3, as appropriate.

1.2.1.2 The certification results in issue of the Lifting Appliances Register and of test certificates mentioned in 1.2.2 or 1.2.3, as appropriate.

1.2.1.3 Certification will not result in the assignment of additional class notations. It will also not be indicated in the Register of Ships.

1.2.2 Certification

1.2.2.1 The certificates issued by IRS on behalf of the Administrations will correspond to the format of certificates recommended by the International Labour Organization (ILO) for listing the appliances in the Lifting Appliances Register.

1.2.2.2 Complete certification of a lifting appliance of a ship or an offshore unit will include:

- approval of the drawings and examination of the documents required in these Guidelines.
- the test and survey certificates prior to the first use of the items of loose gear such as blocks, hooks, shackles, swivels, chain cables, rings, rigging, lifting beams, etc.
- the test and survey certificates prior to the first use of the steel wire ropes and fibre ropes
- the test and survey certificates prior to the first use of the winches
- survey of the onboard fittings in accordance with Section 7
- survey and certification of the general tests prior to first use in accordance with Section 7
- issue of Lifting Appliances Register.

1.2.2.3 The test certificates as per 1.2.2.2 are also to be used when periodical re-tests are carried out and when tests are performed after repairs, conversions or changes in components.

1.2.3 Certification in compliance with National Regulations

1.2.3.1 Certification of lifting appliances in compliance with specific National Regulations will be carried out when IRS is authorized to do so by the competent National Authorities.

1.2.3.2 The forms and formats for the test certificates and the Lifting Appliances Register would be those prescribed by the specific National Regulations. If the National Regulations have not provided specific forms, then the forms of IRS may be used. In such cases, the following is to be clearly indicated:

- precise references of the applicable regulations
- the fact that IRS is recognized and authorized by the concerned Authorities to issue such certificates
- the test procedures required by the specific National Regulations if different from the procedures provided on the form used for the certificate.

1.2.3.3 The Lifting Appliances Register will be issued if the requirements specified in 1.4.2.1 have been complied with to the satisfaction of IRS, considering the special requirements of the National Regulations. Provisions in the specific National Regulations in addition to those included in 1.4.2.1 are to be complied with.

1.2.3.4 When the test load or the test conditions prescribed by the National Regulations for the lifting appliances or their accessories are more severe than the provisions of these Guidelines, they are to be taken into account by the designer to determine the scantlings.

1.2.3.5 As far as lifting appliances already in service are concerned, the minimum requirements to be complied with, are specified in 1.4.2.1.

1.3 Classification of Lifting Appliances

1.3.1 General

1.3.1.1 Vessels or offshore units fitted with lifting appliances complying with the requirements of 1.3.4 or 1.3.5 may be assigned the additional class notations as indicated in 1.3.2.

1.3.1.2 The general principles for assignment, maintenance, suspension and withdrawal of class notations may be referred in the relevant rule sets for ships and offshore structures.

1.3.1.3 Classification results in issue of the Lifting Appliances Register.

1.3.2 Notations

1.3.2.1 The additional class notations that may be assigned are as follows:

LA-H for lifting appliances used in harbour

(LA-H) for lifting appliances used in harbour and complying only with specified National Regulations

LA-O for lifting appliances used in offshore conditions

(LA-O) for lifting appliances used in offshore conditions and complying only with specified National Regulations

The notation **LA-O** may be complemented by **-SUBSEA** when, in addition, the lifting appliances are intended to be used for lifting of subsea equipment and are in compliance with relevant requirements of Section 8.

The additional class notations **LA-H**, **LA-O**, and **LA-O-SUBSEA** may be complemented by **-PER or PER+ or PER++**when, in addition, the lifting appliances are intended to be used for lifting of personnel and they comply with the relevant requirements of Section 8.

1.3.2.2 The additional class notations listed in 1.3.2.1 will be assigned only if the ship or offshore unit is or will be classed with IRS and, the lifting appliances comply with the relevant requirements. The criteria for assigning the class notations listed in 1.3.2.1 are defined in 1.3.3 and 1.3.4.

1.3.3 Criteria for assigning LA-H or LA-O class notations

1.3.3.1 When a lifting appliance is surveyed during construction, it will be subject to the following requirements to grant the vessel or offshore unit one or several of the class notations **LA-H** or **LA-O**:

- approval of drawings and examination of documents required in this document
- inspection of materials and equipment at works in accordance with Section 2
- construction survey in accordance with Section 7
- survey of tests at works prior to fitting onboard, in particular, certification of the loose gear in accordance with Section 4
- survey of onboard fittings in accordance with Section 7
- survey and certification of the general tests before the appliance is put into service, in accordance with Section 7
- issue of the Lifting Appliances Register.

Lifting appliances will be subjected to examinations and periodical tests in accordance with Section 7 to retain Classification.

1.3.3.2 When a lifting appliance has been surveyed by an IACS Member Society during its construction and is requested to be admitted to IRS Classification, it will be assessed to the following requirements for grant of class notations **LA-H** or **LA-O** :

• review of the drawings and documents required by these Guidelines (these drawings are to be marked with the stamps of the organization by which they were approved upon construction.)

• review of materials inspection certificates, construction survey reports, test certificates at works for equipment and loose gear, and, if any, of the existing Lifting Appliance Register

• survey of the lifting appliance concerned (The extent of this survey depends on the existing conditions of certification, on the general maintenance conditions and on the age of the lifting appliances. In general tests are not required if the existing certification for these tests (tests prior to first use and/or renewal of tests as required by Section 7) is valid.)

• issue of the Lifting Appliances Register.

Lifting appliances will be subjected to examinations and periodical tests according to Section 7 in order to maintain Classification.

1.3.4 Criteria for assigning (LA-H) or (**LA-O) class notations**

1.3.4.1 Attention is drawn to provisions in 1.2.3.4 to 1.2.3.6, which are to be complied with.

1.3.4.2 Periodical surveys of such lifting appliances will be carried out in compliance with the requirements of the relevant and respective National Regulations.

1.3.5 Crane Components Certification

1.3.5.1 Crane components will require design review and Unit certification.

1.3.5.2 Design review will be required for following components:

a) Electric Motors (irrespective of power), if considered a critical component
b) Flexible Hoses and Hose End Fittings
c) Hoisting, Slewing, Luffing Winches/Gears (irrespective of their capacity) (Integrated gear boxes are to be design verified if located between the braking safety device and the load.)
d) Hook Blocks
e) All Hydraulic Cylinders (including piston rods)
f) Pressure Vessels and Heat Exchangers of 150 mm in diameter and over and Accumulators, regardless of their diameter
g) Sheaves
h) Swing Circle

1.3.5.3 Unit certification will be required for the following components
a) Electric Motors ≥ 100kW, Electric Motors (irrespective of power, if considered as a critical component)
b) Hoisting, Slewing, Luffing Winches/Gears ≥ 100kW
c) Hook Blocks
d) Critical Hydraulic Cylinders (including piston rods)
e) Pressure Vessels and Heat Exchangers of 150 mm in diameter and over and Accumulators, regardless of their diameter
f) Swing Circle

1.3.5.4 Certified Safe Electrical Equipment are to be Type-tested and certified by a competent, independent testing laboratory for compliance with IEC Publication 60079 or equivalent or Type Approved.

1.3.5.5 Electric Cables are to be tested by the manufacturers in accordance with the standards of compliance and records of test to be maintained and submitted upon request. Construction to be in accordance with the standards specified in Part 4, Chapter 8, Section 3 of the *Rules and Regulations for the Construction and Classification of Steel Ships* (hereinafter referred to as the Main Rules) or Type Approved by IRS.

1.4 Lifting Appliances Register

1.4.1 General

1.4.1.1 Lifting Appliances Register is a document which contains:

- list of all lifting appliances on the vessel or offshore unit which have been certified
- record of periodical examinations and tests required in Section 7 as well as the occasional inspections or tests (and possible observations by the Surveyor)
- certificate details for the lifting appliances.

The updated Lifting Appliances Register is to be available onboard for endorsement by the Surveyor at the time of periodical and damage surveys.

1.4.1.2 The following documentation or equivalent is to be annexed to the register:

- figure showing lay-out and reference marks of the lifting appliances of the ship or offshore unit
- document showing the main characteristics of each lifting appliance (SWL, minimum and maximum working radius or load capacity chart, working area, etc.) and its working conditions (list and trim angles, maximum wind in service, sea condition, etc.), stamped by IRS
- force diagram for each lifting appliance in every working condition (different methods for hoisting, union purchase, etc.) showing the maximum forces applied to the items of loose gear and main structures
- for each lifting appliance, sketch giving useful particulars for correct reeving of ropes and position of every item of loose gear
- for each lifting appliance, list of steel wire and fibre ropes giving their characteristics (specially their minimum breaking load) and list of every item of loose gear with its SWL and its test load
- an operation and maintenance manual prepared by the manufacturer/ builder.

In addition to the above-detailed attachments to the Lifting Appliances Register, the updated manual relating to the lifting appliance is to include the following information and is to is to be kept near the appliance:

- design criteria
- design standards
- list of elements heavily loaded in service
- material specifications
- construction standards
- inspection report during fabrication
- sheaves design standards
- cable specifications
- description and maintenance instruction of brake system

• design standards of pipings and electrical circuits
• diagrams of the latter
• description of safety devices
• instruction for operating, mounting, dismounting and transportation
• instruction for maintenance.

1.4.1.3 The following certificates and forms are usually provided by the builder, manufacturer, testing authority or the firm undertaking annealing (when required). Copies as required and relevant in each case are to be made available for inclusion in the Register.

● ILO Form No. 3 – Certificate of Test and Examination of Chains, Rings, Hooks, Shackles, Swivels and Pulley Blocks

● ILO Form No. 4 – Certificate of Examination and Test of Wire Rope Before Being Taken Into Use.

● Manufacturer's bolt and torque standards for slewing ring

● Approved crane capacity rating chart and corresponding wire rope reeving diagrams

● Manufacturer's procedures for proof-testing of cranes including overriding of limiting devices (where required) to achieve full proof load

1.4.1.4 The following forms and reports are provided and issued by the Surveyors (as applicable) upon completion of prescribed tests and surveys. Copies are to be included in the Register.

● ILO Form No. 2 – Certificates of Test and Examination of Cranes or Hoists and Their Accessory Gear: Before Being Taken Into Use. Retesting Surveys and Tests Associated with Repairs

● ILO Part II – Certificate of Annual Thorough Examination of Gear and for Annual Inspection of Cranes. Reports covering the construction of the crane and any tests carried out at the manufacturer's plant during construction

1.4.1.5 Owner's Overhaul and Inspection Record

A record is to be kept onboard the vessel or unit which is to show particulars of all overhauls, inspections, repairs and replacements carried out by the crane Owner or Operator. This record is to be made available to the Surveyor at all times and in addition to the above requirements is to have specific sections that include:

● A log of the "Rocking Test" results required by Section 7, 7.3 and 7.4, showing the manufacturer's tolerances and the remaining slew bearing clearances calculated from the Rocking Test results.

● A record of the slew bolts inspected, as required by Section 7, 7.5 showing the location of the bolts and a copy of the bolt manufacturing record or certificate, if the bolts have been renewed.

● A copy of the NDT records of all critical weld inspections after proof load testing, as required by 7.3 and 7.4.

1.4.1.6 7 Certificates covering tests after any repairs and alterations are to be inserted in the Register.

1.4.1.6.8 In the event of addition of New Gear and/or Wire Rope, replacement wire rope and loose gear is to be supplied with manufacturer's certificate conforming to tests in accordance with 4.1.3 and 7.1. The wire rope and loose gear certificates are to be inserted in the Lifting Appliances Register and each article and certificate is to be identified as to location in the crane assembly. Certificates covering discarded loose gear are to be removed from the Lifting Appliances Register.

1.4.2 Criteria for issue of Lifting Appliances Register

1.4.2.1 The appliance may be included in the lifting appliances register when the following are carried out to the IRS' satisfaction:

- approval of the drawings and examination of the documents listed in Sec 2
- examination of the test certificates at works of the items of loose gear such as blocks, hooks, shackles, swivels, chain cables, rings, rigging, lifting beams, etc
- examination of the test certificates at works of the steel wire ropes and fibre ropes
- survey of the fitting onboard in accordance with Section 7
- survey and certification of the general tests prior to first use in accordance with Section 7.

When lifting appliances already in service are concerned, the following are carried out to the IRS' satisfaction:

- examination of the drawings and documents required in Sec 2 which are to be submitted for information
    - If the ship does not have a lifting appliances register issued by a recognized organization or a National Authority, the hereinabove mentioned drawings are to be approved by IRS.
    - Upon agreement of IRS, the approval of drawings may not be required if these drawings have been previously approved by an IACS Member Society. In such a case, the above mentioned drawings and documents are to be submitted for information..
    - The documents mentioned in 1.4.1.2, to be annexed to the lifting appliances Register, are to be submitted in any case.
- examination of the certificates issued after testing at works of loose gear, and possibly of the existing cargo gear register
- survey of the lifting appliances concerned.
    - The extent of this survey is to be decided based on the state of the existing certification, the general state of maintenance and the age of the lifting appliances. A re-testing is not required if the existing certification relating to these tests (testing prior to first use and/or 5 Yearly renewal of tests) is valid.

Thickness measurement of structural elements is to be carried out on the lifting appliances the age of which is greater than or equal to 10 years.

1.5 Definitions

Active Heave Compensation System
A system that uses motion sensors and external energy in order to maintain the vertical position of the live load at a predetermined location within a fixed frame of reference.

Active Rope Tensioning System
A system that uses tension measurement devices and external energy in order to maintain the tension on the load hoisting rope at a preset value.

Bearing Raceway
The surface of the bearing rings which contact the rolling element (balls or rollers) of the swing-bearing assembly.

Boom
An arm used for supporting the hoisting tackle at the required outreach.

Boom Angle
The angle to the horizontal of the longitudinal axis of the boom base section.

Boom Head
The outer end of the top section of the boom.

Boom (Luffing) Hoist
A hoist drum and rope reeving system used to raise and lower the boom.

Computer-Based System
A computer-based system is a system of one or more microprocessors, associated software, peripherals and interfaces. Programmable Logic Controllers (PLC), Distributed Control Systems (DCS), PC or server based computation systems are examples of computer-based systems.

Control System
An assembly of devices interconnected or otherwise coordinated to convey the command or order.

Dead Load
Dead Load is the weight of the crane components not included in the live load.

Design Service Temperature (DST)
The Design Service Temperature (DST) is the minimum anticipated temperature at which the crane will operate, as specified by the Owner, crane manufacturer or builder.

Drum
A cylindrical member around which a rope is wound for lifting and lowering the load or boom.

Dynamic Loads
Loads introduced into the crane or its components by forces in motion.

Fail-safe Arrangement
A system is considered to be arranged as fail-safe if failure of a mechanical component will result in the braking or slowing and controlled release of the load. A fail-safe device is a device fitted for such purposes.

Gantry, Mast or "A-frame"
A structural frame, extending above the revolving upper structure to which the boom support ropes are reeved.

Harbour conditions
Still water conditions with significant wave height Hs not greater than 0.6 m.

Heavy Lift Cranes
In general, Heavy Lift Cranes are lifting appliances mounted on barges, semi-submersibles or other vessels, used for lifting and moving loads of not less than 1570 kN in operations such as for construction, shipbuilding, or salvage operations within a harbor or sheltered area or at open sea in very mild environmental conditions; or other environmental conditions specified by the designer.

Jib
An extension attached to the boom head to provide added boom length for lifting specified loads. The jib may be in line with the boom or offset at various angles to the boom.

Kingpost
A vertical post that acts as a centerline of rotation for the revolving upper structure and as the connective member to the platform.

Live Load (LL)
Live Load is the load that is suspended from the boom head, i.e., the sum of the SWL, the weight of the gear (hook, block, wire, etc.) and any other connected component undergoing the same motion as the hook load.

Load Block, Lower
The assembly of hook or shackle, swivel, sheaves, pins, and frame suspended by the hoisting ropes.

Load Block, Upper
The assembly of sheaves, pins and frame at the boom head.

Lock Valve
A valve, such as a counter-balance valve, capable of holding pressure and requiring positive pressure in order to release.

Loose Gear
Any gear by means of which a load can be attached to a lifting appliance, but which does not form an integral part of the lifting appliance or the load.

Minimum Breaking Force
The minimum breaking force of an element is the static force, in kN, corresponding to its minimum breaking load.

Minimum Breaking Load
The minimum breaking load of an element is the minimum mass, in tons, which causes its breaking when applied vertically.

Offboard Lift
A lift by a crane from, or to, anywhere not on the vessel/unit upon which the crane is mounted.

Offlead Load
An offlead load is a horizontal load at the boom tip caused by the radial displacement of the hook and/or the radial acceleration of the boom tip, including the effects of crane base inclination.

Offshore Cranes
In general, Offshore Cranes are lifting appliances mounted on a bottom-supported or floating unit or vessel, used in oil drilling and production operations, as well as for lifting and moving cargo, equipment, supplies and other loads under the environmental conditions specified by the designer while the vessel or unit is at open sea and/or when there may be motion relative to the other vessel or unit during crane operations.

Onboard Lift
A lift by a crane from, or to, a deck of the vessel/unit upon which the crane is mounted.

Passive Heave Compensation System
A system that uses stored energy in order to maintain the vertical position of the live load within a preset range.

Passive Rope Tensioning System
A system that uses stored energy in order to maintain the tension on the load hoisting rope within a preset range.

Pedestal
The supporting structure above which the swing circle mechanism and the revolving upper structure are mounted.

Pitch Diameter
The diameter of a sheave or rope drum measured center to center of the rope (i.e., root diameter of sheave/ drum plus diameter of the rope).

Primary Member or Critical Component
A member or component whose failure would impair the structural integrity of the crane and/or result in loss of control of the load.

Examples of primary structural member:

1 Boom or jib, including upper, lower and insert sections, chord members and lacings (Lacings are considered as primary structural members, unless demonstrated by the designer that failure of one
lacing would not impair the structural integrity of the crane boom.)
2 Center post, gantry, mast or “A”-frame, including chord members and other primary load carrying members
3 Crane base (revolving frame and tub-structure), slew column
4 Load carrying beams
5 Eye plates, lugs and brackets
6 Swing circle assembly and hold down bolts
7 Pins and shafts
8 Crane foundation, pedestal, and kingpost
9 Fasteners loaded in tension in the load path of all primary structural members
10 Hook blocks (Applicable only when treated as special component. See 2-5/1.5 and 2-5/5.)

Examples of critical machinery components:

1 Torque transmitting components of hoisting, luffing, and slewing mechanisms, such as drums, shafts, gears,
couplings, and brakes
2 Winch supports and foundations
3 Luffing, folding, and telescoping hydraulic cylinders

Provision Crane:
A crane that is used for loading and unloading provisions (groceries, housekeeping supplies, etc.) on a vessel/unit.

Radius (Outreach)
The horizontal distance from the axis of rotation to the center of the hoist line(s).

Reeving Diagram
A wire rope system where the rope travels around sheaves and drums (main and auxiliary).

Safe Working Load
The Safe Working Load is the load that each complete crane assembly is approved to lift on the cargo hook, excluding the weight of the gear (hook, block, wire, etc.).

Shipboard Cranes
In general, Shipboard Cranes are lifting appliances mounted on surface-type vessels, used for lifting and moving loads of less than 1570 kN such as cargo, containers, equipment and other loads; or for handling hoses, while the vessel is within a harbor or sheltered area under mild environmental conditions; or under other environmental conditions specified by the designer.

Sidelead Load
A sidelead load is a horizontal load at the boom tip caused by the lateral displacement of the hook and/or the lateral acceleration of the boom tip, including the effects of crane base inclination.

Special Components
Components of special nature, such as hook blocks and sheaves, together with their connecting components, special lifting devices and components built into or for cranes, heavy lift gear, crane hooks or hoisting machinery which are specially designed for use with a particular lifting unit, the designs of which are submitted for approval as steel structural parts.

Standing Rope (Pendant)
A supporting rope that maintains a constant distance between the two components connected by the rope.

Subsea Lifting
Subsea lifting refers to the operation of a crane in which a load is lowered through the splash zone into the water column and is either held at an intermediate level, lowered to or released on the seabed, or is retrieved back to the vessel.

Swing
Rotation of the revolving upper structure for movement of loads in a horizontal direction about the axis of rotation.

Swing Circle (Slewing Ring) Assembly (Pedestal Mounted Cranes)
Swing Circle (Slewing Ring) Assembly is the connection component between the crane revolving upper structure and the pedestal. This component allows crane rotation and sustains the moment, radial and axial loads imposed by the crane operations.

Swing (Slewing) Mechanism
The machinery involved in providing rotation of the cranes′ revolving upper structure.

Swinging Loads
Swinging Loads refers to the use of a single boom to lift a load, with arrangements for changing the position of the boom while supporting the load.

Test loads and forces
The test load of a lifting appliance is the mass, in tons, to be applied vertically upon testing onboard the ship or offshore unit. The test force of a lifting appliance is the static force, in kN, corresponding to its test load. The test load of an item of loose gear is the mass, in tons, to be applied upon its separate testing when test consists in vertical application of a mass. The test force, in kN, of an item of loose gear is either the static force corresponding to its test load or the force to be applied when test consists in application of a force.

Union Purchase
Union Purchase means an arrangement in which a pair of booms is used in combination, the booms being fixed and the cargo runners coupled. Such an arrangement is also known as ″coupled derricks″, ″married falls″, or ″burtoning″.

Dynamic amplification factor (DAF)
Dynamic amplification factor is a factor to address the dynamic and impact effects on the lifted load.

1.7 Documentation

1.7.1 General

Plans showing the arrangements and details of the lifting appliance are to be submitted for review and approval before fabrication begins. These plans are to clearly indicate the scantlings, materials, joint details and welding.

1.7.2 Information to be submitted

The following plans and supporting data are to be submitted for review and approval

1.7.2.1 Structure

.1 General arrangement, assembly plans and description of operating procedures and design service temperature.

.2 Applicable in-service and out-of-service loads, including dead, live and dynamic loads, environmental loads including the effects of wind, snow and ice, load swing caused by non-vertical lifts, loads due to list and/or trim of the vessel or structure, loads due to vessel's or unit's motions, etc.; along with supporting calculations, including details for crane stiffness, relative velocities and vertical distances from boom tip to the deck of the vessel or unit supporting the lifted load, etc.

.3 Details and drawings of all primary structural members and crane supporting structure.

.4 Stress diagram, stress and fatigue analysis and other supporting calculations, suitably referenced. Where computer analysis is used for the determination of scantlings, details of the programs describing input and output data and procedures are to be included together with the basic design criteria.

.5 Wire rope specifications.

.6 General arrangement drawings and specifications for sheaves.

.7 List of the assembled loose gear specifying the Safe Working Load for each component.

.8 Material specifications.

.9 Welding details and a plan indicating extent and locations of nondestructive inspection of welds for crane structure, pedestal, boom rest and foundation(s).

.10 Crane capacity rating charts (load charts) and corresponding wire rope reeving diagrams.

.11 Crane pedestal and foundation (where required) drawings together with calculations indicating the maximum reactions and overturning moments, identifying the portions of each coming from the hoisted load and counterweight if fitted.

.12 Swing circle assembly drawings and details, including, as applicable:

a) Hold down bolt size with calculations, arrangement of bolts, material, grade and pretensioning, together with the method used for pretensioning.

b) Slewing ring drawings, along with static strength calculations and details, which are to include material specifications of raceways and rollers or balls, hardness and heat treatment details of raceways and rollers, number and diameter of rollers or balls, raceway static capacity, specified planarity (flatness) tolerances and surface finish of bearing and supporting flanges, bearing wear tolerances.

c) Procedure for wear down measurement of slewing ring ("rocking test").

.13 Documentation identifying proof load testing weights, locations and conditions, in accordance with Section 7.

.14 For union purchase conditions, plans are to be submitted showing the configuration of the lifting gear, vang and preventer details and locations, hatch opening, coaming height, deck at side, bulwark height, vessel's maximum beam and the boom head location over the hatch and over the side of the vessel.

.15 Drawings showing details of the boom rest (or other stowage arrangement) and its associated supporting structure (where required) are to be submitted; together with stress analysis and other supporting calculations showing the maximum reaction forces and moments in way of boom rest and its foundation.

1.7.2.2 Machinery, Piping and Electric Systems

.1 Description and general details of safety devices and features, such as limit switches, antitwo blocks, etc.

.2 Detailed diagrammatic plans of piping system accompanied by lists of materials, giving size, wall thickness, maximum working pressure and material (including mechanical properties) of all pipes and the type, size, pressure rating and material of pumps, hoses, manifolds, valves and fittings.

.3 Detailed diagrammatic plans of electrical wiring systems including complete feeder lists, type of wire or cable, rating or setting of circuit breakers, rating of fuses and switches, interrupting capacity of circuit breakers and fuses.

.4 Documentation for computer-based systems.

.5 Details of accumulators, heat exchangers and lift and telescoping cylinders indicating shell, heads, pistons, piston rods, lug attachments, tie rod dimensions and threading details, as applicable with material specifications (including mechanical properties).

.6 Details of swing circle mechanism and luffing and hoisting winches, including all torque transmitting components such as drums, brakes, clutches, shafts, reduction gears and coupling bolts and foundation arrangements, as applicable.

.7 Design justification including component strength calculations, stress analysis, material specifications, weld procedure specifications and the extent of nondestructive examination as considered necessary are to be submitted for items .5 and .6 above.

.8 Details of all prime movers such as diesel engines, motors and generators.

.9 A list/booklet identifying all equipment of the crane in hazardous areas and the particulars of the equipment, including manufacturers' names, model designations, rating (flammable gas group and temperature class), the method of protection (flameproof, intrinsically safe, etc.), any restrictions in their use, and document of certification.

.10 A declaration for the absence of asbestos in the manufacture or packaging of all materials, components, equipment, machinery, piping systems and electrical installations.

.11 Personnel lifting and personnel emergency recovery operational procedures, including conditions, precautions and limitations for lifting of personnel. The above items .1 through .8) need not be submitted for small davits/cranes, including Monorail Hoists/Engine Room Overhead Cranes, with SWL of less than 98 kN and without powered slewing systems or powered luffing systems.

.12 Operation and Maintenance Manual for the Lifting Appliance

Section 2

Materials and Testing

2.1 Application

2.1.1 This Section is applicable to materials used for primary structural members, critical machinery components and other miscellaneous components of lifting appliances.

2.2 General Requirements

2.2.1 Materials are to be suitable for the intended service conditions. They are to be of good quality, free of defects and are to exhibit satisfactory formability and weldability characteristics.

2.2.2 Unless specified otherwise, materials used in the construction of lifting appliances are not required to be manufactured at steel works approved by IRS and tests are not required to be conducted in the presence of an IRS Surveyor. Consideration may be given by IRS to accept the works approved by IACS Member Societies.

2.2.3 Where IRS material certification is required, the materials are to be certified in accordance with the applicable sections of Part 2 of the Main Rules.

2.2.4 Materials are to be furnished with certificates issued by the works or the material manufacturer, indicating, as a minimum and as applicable, the material specification, grade, process of manufacture, heat treatment details, mechanical and chemical properties, identification numbers and test results. For those rolled steel products used for crane pedestals and kingposts, the appropriate grade to be used for respective material class and thickness as per Part 2 of the Main Rules.

2.2.5 The manufacturer is to adopt a system for the identification of ingots, slabs, finished plates, shapes, castings and forgings which will enable the material to be traced to its original heat; and the Surveyor is to be given sufficient documentation and means for verifying the traceability of the material.

2.2.6 Materials, test specimens and mechanical testing procedures having characteristics differing from those indicated herein may be approved upon application, with due regard being given to the design criteriaand the purpose for which the material is intended.

2.2.7 Materials other than steel will be specially considered.

2.2.8 Installation of materials which contain asbestos is prohibited.

2.3 Material Selection

2.3.1 Primary Structural Members

2.3.1.1 General

2.3.1.1.1 Primary structural members are to be constructed from steels conforming to the requirements of this Section.

2.3.1.1.2 For lifting appliances with design service temperature −10°C and above, materials for primary structural members are to have fracture toughness suitable for the intended application as evidenced by previous satisfactory marine service experience or are to conform to toughness requirements similar to those indicated in 2.4, except for materials with thicknesses up to 25 mm, which may be tested at the design service temperature.

2.3.1.1.3 For lifting appliances with design service temperature below −10°C, materials for primary structural members are to conform to the toughness requirements of 2.4.

2.3.1.2 Pedestals and Kingposts

2.3.1.2.1 When pedestals or kingposts are welded to the hull structure, the section of the pedestal or kingpost from the hull structure up to the first bolted connection or crane interface, whichever is closer to the deck, is to be constructed of appropriate grade steel selected in accordance with Part 2 of the Main Rules.

2.3.1.2.2 The toughness of the material of the pedestal or kingpost in way of the transition to the hull structure should at least match the hull material to which it is welded.

2.3.1.3 Slewing Rings

2.3.1.3.1 Material specifications for slewing rings are to include as applicable, chemical composition limits, mechanical properties, core hardness requirements, surface hardened layer requirements (hardness range values and hardness depth), inclusion control and limits.

2.3.1.3.2 Materials for slewing rings are to conform to the toughness requirements of 2.4.3. Charpy V Notch tests are to be taken from material representing the core properties. Test certificates issued by the works or material manufacturer are to be submitted to the Surveyor for verification.

2.3.1.4 Critical Machinery Components

2.3.1.4.1 Machinery components are to be constructed from materials which are ductile at the design service temperature, such as steel, nodular iron or spheroidal iron, and which conform to the requirements of this Section.

2.3.1.4.2 Materials used in non-redundant gearbox components are to comply with the elongation requirements of 2.5.2.

2.3.1.4.3 For lifting appliances with design service temperature −20°C and above, materials for critical machinery components are to have fracture toughness suitable for the intended application as evidenced by previous satisfactory marine service experience or are to conform to toughness requirements similar to those indicated in 2.4, except they may be tested at the design service temperature.

2.3.1.4.4 For lifting appliances with design service temperature below −20°C, materials for critical machinery components are to conform to the toughness requirements of 2.4.

2.3.1.4.5 For parts of machinery components not exposed directly to the atmosphere, if the start-up and operating temperature of the equipment is demonstrated to be higher than the design service temperature of the crane itself, then the start-up temperature can be applied as the design service temperature of such parts.

2.3.1.4.6 The materials of pressure retaining components of hydraulic cylinders are also to comply with the requirements of the standard or code to which the cylinder is designed and constructed. Ordinary cast iron having an elongation of less than 12% is not to be used for hydraulic cylinders.

2.3.1.5 Piping Systems

2.3.1.5.1 Piping systems are to be constructed of materials conforming to the requirements of Part 2 and Part 4 of the Main Rules

2.3.1.6 Pressure Vessels

2.3.1.61 Pressure vessels are to be constructed of materials conforming to the requirements of Part 4, of the Main Rules.

2.3.1.7 Bolting

2.3.1.7.1 Bolts are to be in accordance with a recognized bolting standard and are to be selected to comply with the strength and corrosion resistance requirements for the intended service.

2.3.1.7.2 Bolts subjected to tensile loading, other than pre-tensioning (e.g., foundation bolts), employed in joining of primary structural members of lifting appliances are to comply with any of the following toughness requirements:

i) The toughness requirements for bolts of 2.4.4.

ii) The toughness requirements of Table 26 of API Specification 2C – 7th edition.

iii) Fabricated to a standard that specifically covers low temperatures, such as ASTM A320, provided the selected grade is suitable for the intended service temperature.

2.3.1.7.3 Bolts are to be furnished with a traceable test certificate issued by the bolt manufacturer.

2.3.1.7.4 Round bottom and rolled thread profiles are to be used for bolts in critical bolt connections.

2.3.1.7.5 Additional tests, such as hardness tests and magnetic particle inspection 48 hours after final quench and tempering, as deemed necessary by the attending Surveyor, may be required to ensure the quality of the bolt material.

2.3.1.7.6 Bolts are to be permanently marked with fastener manufacturer's identification mark and industry grade, such as SAE, ASTM or ISO.

2.3.1.7.7 Hold-down bolts are to comply with ISO 898-1:2013, or equivalent, and in general are not to be made of material with ultimate tensile strength exceeding 1040 N/mm^2 (10.9 Grade).

2.3.1.8 Sheaves

2.3.1.8.1 Sheaves are to be constructed from materials which are ductile at the design service temperature, such as, steel, nodular iron or spheroidal iron.

2.3.1.8.2 For sheaves built into the structure of the crane and sheaves which are to be treated as special components in accordance with 4.3.10 and 4.2.3, materials are to comply with the impact test requirements of 2.4.5.

2.4 Toughness Requirements

2.4.1 General

2.4.1.1 Charpy V-Notch (CVN) testing procedures are to be in accordance with the requirements of Part 2 of the Main Rules.

2.4.1.2 Charpy V-Notch (CVN) impact testing is not required for plates, structural tubes, castings and forgings, with thickness less than 6 mm.

2.4.1.3 For materials other than steel, the tested Charpy V-Notch values are to be assessed against the ductile to brittle characteristics of the material, in each case.

2.4.1.4 Charpy V-Notch (CVN) impact testing is not required for austenitic stainless steels.

2.4.2 Criteria for Grade Materials

2.4.2.1 Material grades are to be selected based on design service temperature and thickness in accordance with Part 2 of the Main Rules.

2.4.3 Material Toughness Requirements for Slewing Rings

2.4.3.1 Charpy V-Notch impact tests for materials for slewing rings are to be taken from material representing the core properties and are to comply with the following values, when tested at –20°C or at 10°C below the design service temperature, whichever is lower:

4) Minimum Average Energy for 3 (three) Charpy Test bars: 42 J

ii) Minimum Single Energy for each test: 27 J

2.4.4 Toughness Requirements for Bolts Subjected to Tensile Loading

2.4.4.1 Bolts subjected to tensile loading, other than pre-tensioning (e.g., foundation bolts), employed in joining of primary structural members of lifting appliances are to comply with the following Charpy V-Notch impact values when tested at 10°C below the design service temperature:

4) Minimum Average Energy for 3 (three) Charpy Test bars: 42 J

ii) Minimum Single Energy for each test: 27 J

2.4.5 Material Toughness Requirements for Sheaves

2.4.5.1 For steel sheaves of welded and un-welded construction for lifting appliances with design service temperatures of −20°C and above, Charpy V-Notch impact testing is not required.

2.4.5.2 For steel sheaves of welded and un-welded construction for lifting appliances with design service temperatures below −20°C, materials are to meet the requirements of 2.4.3.1, except they may be tested at the design service temperature. In addition, the weld procedures used in the fabrication of the sheaves are to be qualified with the appropriate Charpy V-Notch tests.

2.4.5.3 For metallic materials other than steel, the tested Charpy V-Notch values are to be assessed against the ductile to brittle characteristics of the material, in each case.

2.4.5.4 For non-metallic sheaves, the low temperature characteristics of the materials should be documented and be suitable for the design service temperature.

2.5 Elongation Requirements

2.5.1 General

2.5.1.1 Elongation of steel and other acceptable ductile materials is to meet the minimum requirements of the applicable standard or specification, and the specified elongation is not to be less than 12%.

2.5.2 Elongation Requirements for Non-Redundant Gearbox Components

2.5.2.1 A minimum elongation value of 8% is considered acceptable for high strength case hardened gears or pins constructed in accordance with recognized standards.

2.5.2.2 Nodular or ductile cast iron may be used for flanges, planet carriers or gears in epicyclical type gearboxes, provided the material has a minimum specified elongation of 10%. Lower elongation values may be specially considered for components that are not subject to catastrophic rupture due to abrupt or shock loading generated during operation, as evidenced by previous satisfactory marine service experience for similar applications.

2.6 Steel Plates with Improved Through Thickness Properties (“Z” Quality)

2.6.1 The use of special material with improved through thickness properties, such as “Z” quality steel, is required to be employed in those structural details, where tee or cruciform connections employ fillet,

partial or full penetration welds subject to significant tensile strains, from weld shrinkage or in-service loading, in the through thickness direction, such as pedestal and slewing column flanges, in order to minimize the possibility of lamellar tearing. Materials complying with the testing procedure in Part 3, Chapter 3, Section 8 of the Main Rules to "Z25" quality steel are considered as meeting this requirement.

2.7 Welding

2.7.1 In general, welding may be in accordance with the latest edition of AWS D1.1 "Structural Welding Code – Steel", ASME/ANSI or other recognized codes. Drawings are to indicate the applicable code. Welding procedures are to be to the satisfaction of the attending Surveyor.

2.8 Nondestructive Testing (NDT)

2.8.1 NDT is to be in accordance with the Classification Note *"Requirements for Non-Destructive Testing"* or other recognized codes.

2.8.2 The areas to be nondestructively inspected and methods of inspection are to be submitted together with the design plans. The minimum extent of NDT to be carried out is shown in table below.

Weld Location	Extent and Type of NDT
Critical circumferential welds in crane pedestals, kingposts and transition pieces between the pedestal and the slewing ring	100% Volumetric NDT and 100% Surface NDT of all Complete Joint Penetration (CJP) welds, where welded plate thickness is ≥ 8.0 mm; and 100% MPI of all fillet welds, where plate thickness is ≥ 8.0 mm.
Welds of primary members	20% Volumetric NDT and 100% Surface NDT of all CJP welds, where plate thickness is ≥ 8.0 mm ; and 10% Surface NDT of all fillet welds, where plate thickness is ≥ 8.0 mm.
Other welded connections	Random Volumetric NDT of CJP welds and Surface NDT of fillet welds, only if considered suspect by the attending Surveyor during construction.

2.8.3 NDT procedures and acceptance criteria are to at least satisfy the Classification Note *"Requirements for Non-Destructive Testing*".

2.8.4 Volumetric NDT techniques include Radiographic Testing (RT) and Ultrasonic Testing (UT). Surface NDT techniques include Magnetic Particle Inspection (MPI), Penetrant Testing (PT), Eddy Current (EC) or Alternating Current Field Measurement (AFCM).

2.8.5 Method and extent of nondestructive testing for slewing rings is to be specified by the slewing ring manufacturer. After hardening and finishing, bearing ring raceways are to be inspected by surface NDT along their entire length. Bearing rings are to be 100% ultrasonically tested for internal defects and the manufacturer is to certify that the materials are free from detrimental defects which may impair the performance of the slewing ring.

2.8.6 The Surveyor is to be provided with records of NDT inspections. Additional inspections may be requested at the discretion of the Surveyor.

Section 3

Structure

3.1 General

3.1.1 Primary structural members of crane are to comply with the requirements in this Section. Conditions to be considered in application of these strength criteria are as follows:

i) In-service condition, i.e. crane suspends a load from the cargo hook;

ii) Out-of-service condition 1, i.e. the boom not stowed on boom rest or on other stowage arrangement;

iii) Out-of-service condition 2, i.e. the boom stowed on boom rest or other stowage arrangement.

3.1.2 For cranes approved for varying capacities and/or environmental conditions, crane capacity rating charts (load charts) are to be provided, which are to include at least the following information:

i) Safe Working Load ratings for operating radii increments not exceeding 1.5 m, or corresponding boom angles for the specified boom and jib length

ii) Corresponding environmental conditions, such as significant wave height and wind speed, and vessel inclinations (list and trim)

iii) Corresponding rating conditions, such as onboard or offboard lifting, as applicable

iv) Design Service Temperature (DST) of the crane

v) Corresponding number of wire rope line parts (falls) and/or reference to corresponding wire rope reeving diagrams, as applicable

vi) Weight of the hook, hook block, etc.

vii) The name of the vessel or unit the chart is applicable to, the crane's serial number and manufacturer

3.1.3 An approved copy of the crane capacity rating chart is to be included in the Lifting Appliances Register and is to be furnished to the Owner for use by crane personnel.

3.1.4 For capacity rating chart requirements of cranes used for personnel lifting, see Section 8, 8.1.

3.1.5 Material for structural members and components is to be as specified in Section 2.

3.1.6 The design service temperature (DST) is to be indicated at an appropriate place for the crane operator's information. For lifting appliances approved for varying capacities, it is to be indicated on the crane capacity rating chart.

3.2 Scantlings

3.2.1 Crane boom chords and other members considered to be critically stressed are to have the following minimum thicknesses:

.1 Solid Sections are to be provided with a minimum thickness of 6 mm.

.2 Hollow Sections (e.g., truss boom lacings) are to be provided with a minimum thickness of 4 mm.

.3 Interior of hollow sections is to be either coated or is shown to be weathertight to the attending Surveyor.

3.2.2 For less stressed members, a minimum thickness of 4 mm is to be provided.

3.2.3 Special protective coatings are to be applied to those structural members of the crane where the thickness is less than 6 mm to the satisfaction of the attending Surveyor.

3.3 Loads

3.3.1 Loading Conditions

3.3.1.1 In-service Loads

.1 Typical loads to be considered in the analysis of the cranes, as applicable, are:

i) Dead loads

ii) Live loads and dynamic loads, including the applicable dynamic amplification factors (based on type of crane)

iii) Loads due to vessel's or unit's motions

iv) Wind loads

v) Loads due to list and/or trim

vi) Load swing caused by non-vertical lift

vii) Loads due to snow and ice

.2 The structural analysis of the cranes is to be based on the worst combination of the above loads, as applicable.

.3 If the crane is subject to unusual loads and/or unusual operating conditions, these are also to be submitted and are specially considered for each case.

3.3.1.2 Out-of-service Loads

.1 In addition to the in-service loads, out-of-service loads are also to be considered in the structural analysis of the crane. In an out-of-service condition, no load is to be suspended from the crane's hook.

.2 The out-of-service loads are to include the loads resulting from the weight of the crane and the following environmental and motion loads:

i) Environmental forces (wind, snow and ice, etc.)

ii) Loads due to vessel's or unit's motions

iii) Loads due to list and trim

.3 The designer is to demonstrate, through analysis, that the stresses during out-of-service conditions, with boom stowed and not stowed, do not exceed the allowable stresses.

.4 For extreme conditions of seismic or extreme winds, an increase of up to 33% in the allowable stresses may be used.

3.3.2 Dynamic Amplification Factors

3.3.2.1 Cranes having Safe Working Loads (SWLs) of less than 160 t (Shipboard Cranes) are to be designed for the most severe in-service and out-of-service loading conditions, where the vertical design load due to the lifted load is to be calculated by the following equation:

$$VDL = LL \times DAF$$

where

VDL = vertical design load, in kN

LL = live load, in kN

DAF = dynamic amplification factor

= 1.3 for SWL < 40 t

= 1.366 – SWL/5884 for 40 t ≤ SWL ≤ 160 t

SWL = safe working load, in kN

3.3.2.2 Cranes having Safe Working Loads (SWLs) of not less than 160 t (Heavy lift cranes) are to be designed for the most severe in-service and out-of-service loading conditions, where the vertical design load due to the lifted load is to be calculated by the following equation:

$$VDL = LL \times DAF$$

where

VDL = vertical design load, in kN

LL = live load, in kN

DAF = dynamic amplification factor = 1.1

3.3.2.3 Cranes intended to be operated while the vessel is in open sea, or where there may be motion relative to the other vessel during crane operations, are to meet the requirements for offshore cranes.

3.3.2.4 The above dynamic amplification factors are based on crane operations in mild environmental conditions, where there are no significant accelerations due to vessel's motions. For other environmental conditions, the above dynamic amplification factors are to be increased by adding the respective accelerations as specified by the manufacturer and in accordance with 3.9; but when these accelerations exceed 0.07g, cranes are to meet the requirements for offshore cranes.

3.3.2.5 The total horizontal side load at the boom tip is to be calculated considering all applicable side loads in accordance with 3.3.1, including the effects of vessel motions, wind and vessel inclinations, as per 3.9, 3.10 and 3.11, but is not to be taken less than 0.02 × VDL.

3.3.2.6 The SWL for shipboard grab cranes is not to exceed 80% of the load that each complete crane assembly is approved to lift on the cargo hook. The weight of cargoes lifted by the grab including the weight of the grab and its accessories is not to be greater than the SWL for the grab crane.

3.3.2.7 In heavy lift cranes, hook roller restraining components are to be designed for 1.2 times the live load plus dead load without exceeding the allowable stresses.

3.3.2.8 Operations of Offshore Cranes may consist of lifting and setting loads on the vessel or structure on which the crane is installed (onboard lifts), or on other structures or vessels (offboard lifts). Offshore cranes are to meet the requirements of API RP 2C.

3.4 Allowable Stresses

3.4.1 Computed tensile, bending and shear stress components and, as applicable, combinations of such stresses, for primary structural members are not to exceed the allowable stress, F, as obtained from the following equation:

$F = R_{eH} \times SF$

3.4.2 For steel booms, R_{eH} is specified minimum yield point of the material

3.4.3 For all other steel structural parts, R_{eH} is minimum yield point. For design purposes, for steels with yield strength not exceeding 355 N/mm^2, R_{eH} is to be considered taken as not greater than 72% of the minimum ultimate strength of the steel.

3.4.4 The allowable stress factor, SF, are to be as follows:

.1 Tensile Stress:

Non-Pin Connected members (gross area): 0.60

Pin Connected members (net area): 0.45

.2 Shear Stress:

On the Cross-Sectional Area Effective in Resisting Shear: 0.40

.3 Bending Stress: (Tension and Compression on Extreme Fibers)

Solid Round and Square Bars: 0.75

Members with Compact Sections: 0.66

Members with Non-Compact Sections: 0.60

.4 Bearing Stress:

On contact area of surfaces and projected area of pins in holes: 0.90

.5 Combined Stress:

Von Mises Stress: 0.75

Von Mises Stress using FEM Fine Mesh Analysis with All Loads: 0.85

Notes:
1.Members subjected to combined stresses are to be proportioned to satisfy requirements of 3.5.

3.4.5 Allowable tension and shear stresses for boom and structural component rivets, bolts and thread parts are to be as per recognized standards. For hold-down bolts see 3.6.

3.5 Buckling and Combined Stresses

3.5.1 Members subjected to axial compression or combined loads, such as axial compression and bending moment, are to be assessed in accordance with recognized standards.

3.5.2 For members with non-compact cross sections, the local buckling is to be taken into account and is to be evaluated in accordance with recognized standards.

3.5.3 Design section properties of tapered members are to be determined. The effective length of crane booms may be determined in accordance with Appendix C of BS 2573-1:1983 or other recognized standards.

3.6 Swing Circle (Slewing Ring)

3.6.1 The following requirements apply to swing circle assemblies of Shipboard, Offshore, and Heavy Lift Pedestal Mounted Cranes.

3.6.2 Based on the type of the crane (i.e., Shipboard, Offshore or Heavy Lift), the respective loads and moments are to be considered for the analysis of the swing circle assembly.

3.6.3 The design of flanges and their attachment to the pedestal or other supporting structures is to consider the slew bearing manufacturer's recommendations for maximum permissible flange deflection as well as the degree of flatness of the surface of the flanges that are in contact with the slew bearing.

3.6.4 Where principal loads from either service or weld residual stresses are imposed to the flange through thickness direction, the flanges are to be made of material with improved through thickness properties (Refer Section 2).

3.6.5 The bolt load on the most heavily loaded slewing ring bolt is to be calculated for the most severe in-service loading conditions. The design overturning moment is to be based on a combination of in-plane and side plane loading. Calculation of the bolt load used is to be submitted for review.

3.6.6 The maximum calculated bolt tensile stress is not to exceed the minimum specified ultimate tensile strength of the bolt material.

3.6.7 During installation, the bolts are to be pretensioned by controlled means to the satisfaction of the attending Surveyor. Pre-tensioning, by bolt torque or by hydraulic tensioning device, is to be in accordance with the bearing manufacturer's instructions and is not to exceed 0.7 times the bolt yield strength for bolts pretensioned by torque or 0.9 times the bolt yield strength for bolts pretensioned by axial tension.

3.6.8 Elongation of the bolts is to be measured to verify pre-tensioning. At least 10 percent of the bolts, randomly selected, are to be measured to the satisfaction of the attending Surveyor.

3.6.9 The material used in hold-down bolts is to be in accordance with Section 2.

3.6.10 Where the swing circle assembly utilizes a roller or ball bearing slewing ring, the inner and outer bearing rings are to have a 360-degree uniform bolting pattern. Consideration will be given to the use of sector bolting arrangement, provided a detailed structural analysis which includes side loading of the race, rings and bolted connection is submitted for review.

3.6.11 Where sector bolting is used, it is not to be less than 140-degree sectors and at least one additional bolt is to be fitted at the mid-point between each 140-degree sector where sectors extend to include a full circle. The center of each 140-degree sector is to be in line with the centerline of the boom.

3.6.12 The most severe loading at the slewing ring, based on the loads and moments of 3.3 as applicable, is not to exceed the static capacity of the raceways, as specified by the bearing manufacturer. The design of bearing raceways is to take into consideration the maximum permissible bearing wear over the life of the bearing, as specified by the bearing manufacturer.

3.6.13 The slew bearing is to be sealed to prevent the ingress of foreign matter and contamination. A greasing nipple is to be provided for lubrication. Lubrication holes are not to terminate on bearing raceways, except for ball bearings, where they are to be located outside the contact path of the ball bearings. The edges of lubrication holes are to be sloped gently so as to avoid sharp edges.

3.6.14 Retaining components of slewing rings are to be designed for the overturning moments and vertical loads, as calculated based on the loads of 3.3.3, using 3.75 times the vertical design load (see 3.3.2), of the most severe in-service loading conditions. The overturning moment is to be based on a combination of in-plane and side plane loading. The calculated stresses are not to exceed the ultimate tensile strength of the respective materials of the retaining components.

3.6.15 An auxiliary device to restrain the upper frame against separation from the pedestal may be supplied at the option of the buyer. When the auxiliary device is supplied, the properties of materials used in its design and manufacture should be selected to resist fracture under impact loading. The maximum calculated stress, based on the loads of 3.6.14, is not to exceed the minimum specified ultimate tensile strength of the material.

3.6.16 Materials used in the swing circle assembly are to be in accordance with Section 2.

3.7 Pedestals, Kingposts, Foundations, and Supporting Structure

3.7.1 Crane pedestals, kingposts, foundations, and supporting structure are to be designed for the maximum reaction forces and moments due to most severe in-service and out-of-service loading conditions, in accordance with 3.3, where the horizontal and vertical loads due to the live load, including the applicable dynamic amplification factors, in accordance with 3.3.2, are to be multiplied by the factor as obtained from the following equation:

$k = 1.56 – (LL[kN]/4000)$

k is not to be taken greater than 1.5 for all crane types, and
k is not to be taken less than 1.2 for Offshore Cranes or less than 1.0 for Heavy Lift Cranes.

3.7.2 No doubler plate is permitted between the pedestal and deck plate where any tension load is anticipated.

3.7.3 Detail drawings of the foundation and supporting structure on which the crane is to be installed are to be submitted and approved by IRS prior to certification.

3.7.4 These components are to meet the applicable allowable stresses without the 33% increase for extreme conditions of seismic loads or extreme winds as indicated in 3.3.1.2.

3.8 Boom Rest or other Stowage Arrangement

3.8.1 Where required by the crane design, a boom rest (or other stowage arrangement) is to be provided and it is to comply with the following:

i) The boom rest together with its foundation, is to be designed for the worst case out of-service conditions with the boom in the stowed position:

a) The design loads are to include the out-of-service loads specified in 3.3.1.2.

b) The calculated stresses are not to exceed the allowable stresses given in 3.4. For extreme conditions of seismic loads or extreme winds, an increase of up to 33% in the allowable stresses may be used for boom rest only.

ii) The detailed structural drawings and strength analysis for the boom rest and its foundation are to be submitted for review prior to certification of the crane.

3.9 Loads due to Vessel's or Unit's Motions

3.9.1 Vertical and horizontal accelerations due to vessel's or unit's motions are to be determined based on vessel motion analysis and are to be submitted and considered in the analysis of Offshore Cranes, as per 3.3.2.8, and as applicable of Shipboard and Heavy Lift Cranes, as per 3.3.2.4.

3.9.2 The vertical load due to each crane component is to be calculated by the following equation:

$$VL_{DL} = DL\ (1 + a_v)$$

where

VL_{DL} = vertical load due to dead load, in kN

DL = component's dead load, in kN

a_v = vertical acceleration, in g

3.9.3 The horizontal load due to each crane component is to be calculated by the following equation:

$$HL_{DL} = DLa_h$$

where

HL_{DL} = horizontal load due to dead load, in kN

DL = component's dead load, in kN

ah = horizontal acceleration, in g

The calculated vertical loads (VL_{DL}) and horizontal loads (HL_{DL}) are to be applied at the center of gravity of each crane component.

3.9.4 The horizontal load due to the lifted load is to be calculated by the following equation:

$$HL_{LL} = VDLa_h$$

where

HL_{LL} = horizontal load due to live load, in kN

VDL = vertical design load, in kN; see 3.3.2

ah = horizontal acceleration, in g

The calculated horizontal load (HL_{LL}) is to be applied at the boom tip.

The angle of application of the horizontal loads is to be taken as such so as to induce the maximum loading on the crane.

3.10 Loads due to Wind

3.10.1 The wind velocities during in-service and out-of-service conditions (boom stowed and not stowed) are to be specified by the manufacturer, are to include the effects of gusts and vertical distance from the water surface to the crane location and are to be submitted and considered in the analysis of the cranes in accordance with 3.3.10.2 and 3.3.10.3.

3.10.2 Wind pressure and loads are to be considered in accordance with Chapter 4, Section 2 of the MODU Rules. Apart from the shape coefficient (Cs) values mentioned in Chapter 4, Section 2 of the MODU Rules, following are to be used

Wires: 1.2
Small parts: 1.4
Lattice booms and derricks (each face): 1.25

Note: Shapes or combinations of shapes which do not readily fall into the specified categories will be subject to special consideration.

3.10.3 The wind force is to be calculated in accordance with the following equation for the live load and each crane component and the resultant force and point of application is to be determined.

$$HL_{wind} = PA$$

where

Hlwind = horizontal wind force, in kN

P = wind pressure, in kN/m^2

A = projected area, in m^2, of all exposed surfaces

In calculating the wind forces, the following procedures are recommended:

i) The projected area of the live load is to be specified by the manufacturer

ii) Open truss work commonly used for booms, certain types of masts, etc., may be approximated by taking 30% of the projected block areas of both the front and back sides (i.e., 60% of the projected block area of one side for double sided truss work). The shape coefficient is to be taken in accordance with 3.3.10.2.

iii) Wind forces are to be added in the horizontal loads of the live load and each crane component.

3.11 Loads due to List and Trim

3.11.1 Loads for each crane component (dead load) and the lifted load(live load) due to the static inclination angles (list and trim) of the vessel or unit are to be applied as horizontal side loads at the center of gravity of each crane component and at the boom tip for the lifted load.

3.11.2 While calculating the respective horizontal side loads, dead load is to include the effect of vertical accelerations, in accordance with 3.9, as applicable, and live load is to include the applicable dynamic amplification factor, in accordance with 3.3.2.

3.11.3 The static inclination angles, as specified by manufacturer, for in service and out of service conditions, for vessels and units are to be taken into consideration in the calculation of loads due to list and trim.

3.12 Fatigue

3.12.1 For offshore cranes, fatigue analysis for the life expectancy of the crane, performed in accordance with a recognized method, such as API Spec 2C , is to be submitted for review.

Section 4

Wire Rope and Loose Gear

4.1 Wire Ropes

4.1.1 General

4.1.1.1 The construction of the wire rope is to comply with a recognized standard such as API Spec 9A, EN 12385 or ISO 2408:2017.

4.1.1.2 The hoisting and luffing steel wire ropes are to be in accordance with the following:

i) Rotation resistant rope is to be given special care in installations, so as to prevent possible damage.

ii) Socketing is to be carried out as recommended by the manufacturer of the wire rope or fitting.

iii) If a load is supported by more than one part of rope, the tension in the parts is to be equalized.

iv) Tie-downs (kicker devices) are to have locknuts or other provisions to prevent loosening.

4.1.2 Factors of Safety

4.1.2.1 General

4.1.2.1.1 The minimum breaking strength of running and standing wire ropes is not to be less than the maximum tension in the rope multiplied by the factors of safety(Sf), for the appropriate crane type, obtained in accordance with the below.

.1 Shipboard Cranes:

a) Wire rope for Load (Main & Aux.) Hoist & Boom Hoist Rigging, Standing Rigging and Pendants

$$Sf = 5 \; for \; SWL < 10 \; t$$

$$Sf = 5 - \frac{(SWL - 10)}{50} \; for \; 10t \; \leq SWL < 60t$$

$$Sf = 4 - \frac{(SWL - 60)}{100} \; for \; 60t \; \leq SWL < 160t$$

.2 Heavy Lift Cranes:

a) Wire rope for Load and Boom Hoist Rigging, Sf = 3
b) Wire rope of Aux. Hoist Rigging Above 160 t, Sf = 3
c) Wire rope of Aux. Hoist Rigging below 160 t, refer 4.1.2.1.1.1 a)
d) Wire rope for Standing rigging and pendants, Sf = 3

Note: If the crane needs to comply with the ILO Regulations at the request of the Authorities where the crane will be operating, selection of wire ropes for both running and standing rigging is to be in accordance with 4.1.2.1.1.1 a)

.3 Offshore Cranes:

a) Wire rope for Load (Main and Auxiliary.) Hoist and Boom Hoist Running Rigging

$$S_{f1} = \frac{10000}{8.682\ LL + 1910}, \qquad not\ greater\ than\ 5$$

$$S_{f2} = 2.25\ \times VAF$$

$$S_f = \max(S_{f1}, S_{f2}), not\ greater\ than\ 3$$

b) Standing rigging and pendants

$$S_{f1} = \frac{10000}{5.5.12\ LL + 2444}, \qquad not\ greater\ than\ 4$$

$$S_{f2} = 2\ \times VAF$$

$$S_f = \max(S_{f1}, S_{f2}), not\ greater\ than\ 3$$

4.1.2.1.2 The maximum tension in the rope is to be calculated by the formula in 4.1.2.2, where:

.1 For main and auxiliary load hoist ropes, the total load is to be based on the Live Load.

.2 For boom hoist ropes and pendants, the total load is to be based on the boom in-plane loading, which is to include, as applicable, the effects of the Live Load, dead load with accelerations of the vessel or unit, wind loading on the boom and lifted load.

4.1.2.2 Rope Tension or Line Pull Force

The tension or line pull force in the rope is to be calculated by the following formula:

$$T = \frac{L}{N\ E}$$

where
T = tension or line pull force in the wire rope, in N
L = total load on the rope, in N
N = number of wire rope line parts (falls) supporting the total load
E = efficiency of the wire rope reeving system, to be determined from the following equation:

$$E = \frac{(K^N - 1)}{K^S N(K - 1)}$$

where
E = efficiency of the wire rope reeving system
N = number of wire rope line parts (falls) supporting the total load
S = number of sheaves in the reeving system
K = friction loss per sheave constant; not less than 1.045 for sheaves with bronze bearings and not less than 1.02 for sheaves with roller or ball bearings
Special consideration may be given to lower friction loss per sheave constants, provided that the values are demonstrated by way of testing.
For standing ropes, the reeving system efficiency may be taken as 1.

4.1.3 Wire Rope Test

4.1.3.1 All wire ropes are to have a test certificate, furnished by the manufacturer or the certificating authority, showing the breaking test load of a sample.

4.1.3.2 The certificate is to also indicate standard of construction, size of rope, number of strands, number of wires per strand, lay, core, quality of wires, date of test, and is to be submitted for inclusion in the Register of Lifting Appliances.

4.1.4 Splicing of Wire Rope

4.1.4.1 Single wire rope cargo falls, wire rope pendants, topping lifts and preventers are to consist of clear lengths without splices except splices are permitted at the ends.

4.1.4.2 Such eye splices are to be made in accordance with recommendations of the rope, crane manufacturer.. Rope thimbles are to be used in the eye. A thimble or loop splice made in any wire rope is to have at least three (3) tucks with a whole strand of the rope and two (2) tucks with one-half of the wires cut out of each strand, provided that this requirement shall not preclude the use of another form of splice which can be shown to be as efficient as that required in this subsection. Bolted cable clips for splicing wire rope are not acceptable.

4.1.5 Reeving Accessories

4.1.5.1 Swaged, compressed, or wedge socket fittings are to be applied as recommended by the rope, crane, derrick, or fitting manufacturer.

4.1.5.2 Wire rope clips used in conjunction with wedge sockets are to be attached to the unloaded dead end of the rope only.

4.1.5.3 Wire rope clips are not to be used to form eyes in the working ends of single wire rope cargo falls.

4.2 Loose Gear

4.2.1 General

4.2.1.1 All chains, rings, hooks, links, shackles, swivels, and blocks of crane are to be tested with a proof load at least equal to the following:

Item	Test load, in tonnes
Single sheave block	4 x SWL
Multi-sheave blocks and hook blocks:	
SWL ≤ 25 t	2 x SWL
25 t < SWL ≤ 160 t	(0.993 x SWL) + 27
160 t < SWL	1.1 x SWL
Hooks, shackles, chains, rings, swivels, etc.:	
SWL ≤ 25 t	2 x SWL
25 t < SWL	(1.22 x SWL) + 20
Lifting beams, spreaders, frames, grabs:	
SWL ≤ 10 t	2 x SWL
10 t < SWL ≤ 160 t	(1.04 x SWL) + 9.6
160 t < SWL	1.1 x SWL
Note 1. Sheave blocks that are permanently attached to, or are integral with the hook, are called hook blocks. Hook blocks are to be tested with the load for multi-sheave blocks. The hook of the hook block is to be tested with the loads for hooks. Note 2. The SWL for a single sheave block, including single sheave blocks with beckets, is to be taken as one half of the resultant load on the head fitting. Note 3. The SWL of a multi-sheave block is to be taken as the resultant load on the head fitting.	

4.2.1.2 The safe working load to be marked on a single sheave block is to be the maximum load which can safely be lifted by the hook suspended from the body of the block.

4.2.1.3 Evidence of compliance with the proof load test requirements for all rings, hooks, links, shackles, swivels, blocks, and any other loose gear whether accessory to a machine or not, but which is used as crane gear is to be listed on an appropriate certificate as required by 4.2.2.

4.2.1.4 Loose gear are to undergo NDE after proof load testing in accordance with a recognized standard, such as DOE STD 1090:2020, ASME B30.10:2019, ASTM E709:2021 (MT), and ASTM E165:2023 (PT), by the loose gear manufacturer. Results are to be made available to the Surveyor upon request.

4.2.1.5 Structure, loose gear, and/or containers used solely for shipping or transferring equipment to offshore units are not subject to the requirements of this Section.

4.2.2 Certificates

4.2.2.1 Articles of loose gear are to have a certificate furnished by the manufacturer.

4.2.2.2 The certificate is to show the distinguishing number or mark applied to the article of gear, description, kind of material, carbon content, date of test, proof load applied, and safe working load. Loose gear certificates are to be inserted in the Lifting Appliances Register.

4.2.2.3 The safe working load SWL is to be marked on the hoist blocks.

4.2.3 Markings

4.2.3.1 Loose gear are to be clearly and permanently marked with its unique identification (serial no.), the SWL and any additional marks required for safe use.

4.2.3.2 In addition, specific types of loose gear should be marked with the following minimum information:

.1 ramshorn hooks:

a) range of sling angle;

.2 block and hook blocks;

a) rope diameter;

b) rigging plan identification mark (for blocks) if any;

.3 lifting beams, spreaders, frames;

a) tare weight;

b) allowable sling angles;

c) details of the safe application of the SWL in case of complex equipment which can be utilized in different ways;

.4 grabs;

a) tare weight;

4.2.3.3 If there is insufficient space for the marking on the loose gear other than the SWL, the omitted information should be included in the certificate or be provided by other suitable means.

4.2.4 Special Components

4.2.4.1 Blocks of special nature, together with their connecting components, special lifting devices and components built into or for cranes, heavy lift gear, crane hooks or hoisting machinery which are specially designed for use with a particular lifting unit, the designs of which are submitted for approval as steel structural parts (including hook curves indicating the hook load reductions based on sling angle and eccentricity, as applicable), in accordance with Section 3, need not be considered as loose gear for the purpose of certification. For material requirements, see Section 2. Surveys during construction at the component manufacturer's works are to be carried out in accordance with Section 7, 7.2; testing and examination are to be carried out with the gear as a unit, as required by Section 7, 7.3.

4.2.4.2 For crane hooks, appropriate nondestructive examination, in accordance with a recognized standard, such as DOE STD 1090:2020, ASME B30.10:2019, ASTM E709:2021 (MT), and ASTM E165:2023 (PT), is to be performed after proof load testing to the satisfaction of the attending Surveyor.

4.2.4.3 Non-destructive examination will also be required for other components where visual inspection is considered to be inadequate.

4.2.5 Sheaves

4.2.5.1 Sheaves grooves are to be smooth and free from surface defects which could cause rope damage.

4.2.5.2 The cross-sectional radius at the bottom of the groove is to be such so as to form a saddle for the size of rope used; the sides of the groove are to be tapered outwards to facilitate entrance of the rope into the groove.

4.2.5.3 Flange corners are to be rounded and the rims should run true about the axis of rotation.

4.2.5.4 All sheaves including running blocks are to be provided with guards or other suitable devices to prevent the rope from coming out of the sheave groove.

4.2.5.5 Means are to be provided, if necessary, to prevent chafing of the ropes.

4.2.5.6 All sheave bearings are to be provided with means for lubrication. Permanently lubricated bearings are exempt from this requirement.

4.2.5.7 Sheave pitch diameter to rope diameter ratio for crane running wire ropes is not to be less than 18, or 20 for sheaves used in motion compensation systems, and for standing rigging wire ropes is not to be less than 10.

4.2.5.8 The diameter inside of the sheave groove is to be in accordance with the wire rope manufacturer's instructions. In general, for steel sheaves this diameter is between 6% and 8%, and between 3% and 27% for cast nylon sheaves, larger than the rope diameter.

4.2.5.9 Where sheaves are built into the structure of the crane, they need not be tested and certified as loose gear, but will be accepted based on verification of compliance with the requirements of above, material verification in accordance with Section 2 and testing and examination with the gear as a unit in accordance with Section 7, 7.3. Materials are to be as required in 2.3.1.8.

4.2.5.10 Sheaves of special nature which are specially designed for use with a particular lifting unit, the designs of which are submitted for approval as steel structural parts, are to be treated as special components in accordance with 4.2.4. For sheaves made of polymer materials known as Type 6 cast nylons, the allowable stresses for bending, shear, compression, bearing etc. are to be limited to 30% of the corresponding material strength for bending, shear, compression, bearing, etc. Materials are to be as required in 2.3.1.8.

4.2.6 Hooks and Hook Blocks

4.2.6.1 General

4.2.6.1.1 Hook blocks are to be of sufficient weight to overhaul the line from the highest hook position giving consideration to the boom length, jib length, as well as the number of parts of line in use.

4.2.6.1.2 Hook blocks are to be permanently labeled with their maximum rated capacity and weight.

4.2.6.1.3 Hooks are to be equipped with latches, unless equivalent means are provided to retain the rigging on the hook. When provided, the latch is to bridge the throat opening of the hook for the purpose of retaining slings or other lifting devices, under slack conditions.

4.2.6.1.4 When hooks and hook blocks are used for personnel lifting, they are to comply with the additional requirements of 8.1.3 of this document.

4.2.6.2 Shipboard Cranes

4.2.6.2.1 Main and auxiliary hook blocks and hooks for shipboard cranes may be accepted as loose gear on the basis of testing and manufacturer certification in accordance with 4.2.1 and 4.2.2. Alternatively, they may be certified as “Special Components” in accordance with 4.2.4. When hooks and hook blocks are certified as “Special Components”, the design loads are to be calculated as per 3.3.2.1 of this document. The calculated stresses are to be in compliance with 3.3.

4.2.6.3 Offshore and Heavy Lift Cranes

4.2.6.3.1 General

.1 Main and auxiliary hook blocks and hooks for offshore and heavy lift cranes are to be certified as “Special Components” in accordance with 4.2.4.

.2 For mass produced hook blocks, acceptance may be based on satisfactory design review and manufacturer’s loose gear test certificate.

4.2.6.3.2 Design

.1 For offshore and heavy lift cranes, the design loads for hooks and hook blocks are to be calculated as per 3.3.2.

.2 The calculated stresses for hooks and hook blocks are to be in compliance with Section 3.

4.2.6.3.3 Hooks

.1 Hooks are to comply with a recognized standard for hooks such as DIN15400:1990.

.2 Hooks are to be fabricated from alloy steel and are to be produced as forgings or castings. They are to meet the requirements for structural material as per Section 2.

.3 Hook materials are to comply with the following Charpy V-notch impact values when tested at 10°C (18°F) below the design service temperature:

i) Minimum average energy for three (3) Charpy tests bars: 34 Joules

ii) Minimum Single Energy for each test: 20 Joules

After proof load testing, hooks are to be inspected and undergo nondestructive examination, performed in accordance with a recognized standard, such as DOE STD 1090:2020, ASME B30.10:2019, ASTM E709:2021 (MT), and ASTM E165:2023 (PT), to the satisfaction of the attending Surveyor.

Section 5

Machinery and Piping

5.1 General

5.1.1 The mechanical, piping and electrical systems and components of the crane are subject to design review for compliance with the requirements of this Section.

5.1.2 Materials for machinery systems and components are to be in compliance with Section 2.

5.1.3 For cranes with a Design Service Temperature below –10°C, the manufacturers of the machinery systems are to demonstrate by way of testing or analysis that these systems will operate satisfactorily at the design service temperature.

5.2 Piping Systems

5.2.1 In general, piping systems are to be designed, constructed, installed and tested to the requirements contained in these Guidelines, and in accordance with Part 4, Chapter 3 of the Main Rules, as relevant and applicable .

5.2.2 Hydraulic oil and pneumatic systems are to be designed, constructed, installed and tested to the requirements contained in these guidelines, and in accordance with Part 4 of the Main Rules, as relevant and applicable.

5.3 Pressure Vessels

5.3.1 Pressure vessels are to be designed, constructed, installed and tested to the requirements contained in these guidelines, and in accordance with Part 4, Chapter 5 of the Main Rules, as relevant and applicable.

5.4 Rotating Machines

5.4.1 General

5.4.1.1 Internal combustion engines, electrical motors, generators and other rotating machines whose failure would not result in loss of control of the load, (refer Section 1, 1.5), are to be designed, constructed and equipped in accordance with good marine practice and are to comply with the design requirements of the crane for items such as operating temperature, duty cycle, and angle of inclination, as specified in the crane capacity rating charts or designer’s specification.

Such equipment need not be surveyed at the manufacturer’s works, but will be accepted based on manufacturer’s certificate, verification of the nameplate data and satisfactory performance testing witnessed by the Surveyor after installation on the crane.

5.4.2 Electric motors and other rotating electrical machines

5.4.2.1 Electric motors and other rotating electrical machines that are used for transferring braking torque and/or whose failure would result in loss of control of the load are to be designed, constructed, installed and tested to the requirements contained in these Guidelines, and in accordance withof Part 4, Chapter 8 of the Main Rules, as relevant and applicable. The test certificates are to be made available when requested by the Surveyor. Acceptance will be based on design review and satisfactory performance testing witnessed by the Surveyor after installation on the crane.

5.4.3 Internal Combustion Engines

5.4.3.1 Internal combustion engines having a rated power of 100 kW and over are to be provided with safety features as per Part 4, Chapter 4, 4.6 of the Main Rules.

5.4.3.2 Internal combustion engine exhaust manifolds are to be water jacketed or effectively insulated. Fuel tank fills and overflows are not to run close to exhausts. The exhaust is to be fitted with an effective means of spark arresting. Exhaust piping insulation is to be protected against possible absorption of oil or hydraulic fluid in areas or spaces where the exhaust piping may possibly be exposed to oil, oil vapors or hydraulic fluid leakage. (Internal combustion engines may be required to be in compliance with MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships. The designer is advised to be cognizant of the relevant flag Administrations and Port State requirements).

5.5 Hazardous Areas

5.5.1 Electrical equipment, including all electrical power, control and safety devices and wiring on cranes installed in hazardous areas are to be suitable for operation in such areas and are to be in accordance with the relevant requirements of Part 4, Chapter 8, Section 11 of the Main Rules.

5.5.2 Where essential for operational purposes, internal combustion engines and mechanical equipment may be installed in hazardous areas and such installation will be subject to special consideration.

5.5.3 In general, exhaust outlets are to discharge outside of all hazardous areas, air intakes are to be not less than 3 m from hazardous areas and any parts of equipment whose surface may exceed 200°C are to be effectively insulated, cooled or protected by other means.

5.6 Winches

5.6.1 General

5.6.1.1 Hoisting winches are to provide a line pull force, with the rope in the outer layer of the drum, calculated in accordance with Section 4, 4.1 for a total load based on the Live Load.

5.6.1.2 Luffing winches are to provide a line pull force in the boom hoist wire rope, calculated in accordance with Section 4, 4.1 for a total load based on the boom in-plane loading, which is to include, as applicable, the effects of the Live Load with the applicable dynamic amplification factors, dead load with accelerations of the vessel or unit, wind loading on the boom and lifted load.

5.6.2 Drums

5.6.2.1 General

.1 Not less than five (5) full wraps of wire rope are to remain on the drum under all operating conditions..

.2 Drums are to have a pitch diameter of not less than 18 times the nominal diameter of the wire rope. For drums used in motion compensation, the pitch diameter is not to be less than 20 times the nominal diameter of the wire rope.

.3 Groove radii for grooved drums are to be in accordance with 4.3. Typically, a spooling device should be provided in front of the drum where the fleet angle is greater than 4° for single layered drums and 2° for multiple layered drums.

5.6.2.2 Stresses

.1 The hoop stress on the drum shell is not to exceed 0.85 times minimum specified yield stress of the material.

.2 The equivalent stress is not to exceed 0.66 times minimum specified yield stress of the material.

.3 Where the expected number of hoisting cycles in the drum is above 10^5, fatigue is to be taken into consideration.

5.6.2.3 Drum Flanges

.1 The drum flanges of winches are to extend a minimum distance of 2.5 times the diameter of the rope over the outermost layer, unless additional means of keeping the rope on the drum are provided (such as keeper plates, rope guards, etc.).

.2 Drum flanges and their connections to the drum shell are to withstand the horizontal components of the outward radial forces of the wire ropes, as calculated with the maximum number of wire rope layers on the drum and the static line pull force. The calculated stresses are not to exceed the allowable stresses of Section 3. The arrangement of the connection of the flange to the drum is to be such as to avoid stress concentration due to relative deformation of the flange and drum.

5.6.3 Brakes

5.6.3.1 General

.1 Hoisting and luffing winches are to be provided with at least a static and a dynamic brake, which may act through the same load path.

.2 Brakes are to be of a fail-safe design (are to engage automatically in case of control or power failure).

.3 Mechanisms such as ratchets and pawls are not to be used as dynamic or static brakes.

.4 The friction factor to be used in the calculation of the braking capacity of dynamic and static brakes is not to exceed 0.3.

.5 Where dry friction is used, precautions are to be taken to avoid lubricants or moisture to contaminate brake disc or pads.

.6 Brakes are to be provided with means of adjustment, where necessary, to compensate for wear and to maintain the spring force on spring-loaded brakes.

5.6.3.2 Static Brakes

.1 For hoisting winches, static brakes are to be capable of holding 1.5 times the torque induced by the line pull force in the wire rope for a total load based on the Live Load.

.2 For luffing winches, static brakes are to be capable of holding 1.5 times the maximum torque induced by the line pull force in the wire rope for a total load based on the boom in-plane loading, which is to include, as applicable, the effects of the Live Load with the applicable dynamic amplification factors, dead load with accelerations of the vessel or unit, wind loading on the boom and lifted load.

.3 The line pull force in the wire rope is to be calculated in accordance with 4.1; except the reeving efficiency may be taken as 1 (E = 1).

5.6.3.3 Dynamic Brakes

.1 Dynamic brakes are to be capable of retarding and stopping the line pull force in the wire rope, without overheating or damage, which is to be demonstrated during crane testing (refer to Section 7).

.2 The line pull force in the wire rope is to be calculated in accordance with 4.1 for the total loads indicated in 5.6.2.1; except the reeving efficiency may be taken as 1 (E = 1).

.3 Dynamic brakes based on hydraulic restrictions, such as lock valves, are to be directly mounted to the hydraulic actuator without the use of hoses.

.4 Lock valves are to have a design rated pressure of at least 1.5 times the working pressure or as an alternative, are to be tested to at least 1.5 times the working pressure and a test certificate is to be submitted.

.5 Where hydraulic circuits of closed type are used, additional precautions are to be taken in the setting of the valves to avoid the motor working against static brakes. This is to be demonstrated during crane testing (refer to Section 7).

.6 Regenerative power braking mechanisms, which in case of failure in the electric power supply will automatically disengage, are to be combined with a fail-safe brake and will be subject to special consideration.

5.6.4 Winch Supporting Structure

5.6.4.1 Winch supporting structure is to be designed for the greater of the following:

.1 Two (2) times the maximum reactions induced by the maximum tension in the rope in accordance with 4.1.2.1.1.

.2 The maximum reactions induced by the line pull force in the wire rope, calculated in accordance with 4.1, for a total load for hoisting winches based on Live Load times the applicable dynamic amplification factor, *DAF* (refer to Section 2); and; for a total load for luffing winches based on the boom in-plane loading, which is to include, as applicable, the effects of the Live Load with the applicable dynamic amplification factors, dead load with accelerations of the vessel or unit, wind loading on the boom and lifted load.

5.6.4.2 The maximum reactions are to be calculated for the worst loading combination of line pull forces and inclinations of the wire rope, with the force applied on the outer layer of the drum. The calculated stresses are not to exceed the allowable stresses in Section 2.

5.6.4.3 Winch foundation bolts are to conform to the material requirements of Section 2. Bolt preloading is to be such that contact between winch foundation and crane structure is maintained under all loading conditions.

5.6.4.4 When braking torque is applied on one side of the drum supporting structure, reactions due to torque are to be applied only to the side of the foundation containing the brake, unless it is demonstrated that supporting structure is rigid enough to evenly distribute the reactions on both sides.

5.7 Swing (Slewing) Mechanism

5.7.1 Swing (slewing) mechanisms are to be powered to rotate the crane even in the most unfavorable combination of transverse loading due to the effects, as applicable, of live load, dead load with accelerations and inclinations of the vessel or unit, and wind loading on the boom and lifted load, during in-service and out-of-service, with boom not stowed, conditions.

5.7.2 Swing (slewing) mechanisms are to be provided with at least a static brake.

5.7.3 Total installed static braking capacity is to be sufficient to hold the crane in the most unfavorable combination of transverse loading due to the effects, as applicable, of live load with the applicable dynamic amplification factors, dead load with accelerations and inclinations of the vessel or unit, and wind loading on the boom and lifted load, during in-service and out-of-service, with boom not stowed, conditions.

5.8 Gearboxes

5.8.1 Gearboxes, including their couplings and shafts, are to be designed, constructed, installed and tested to the requirements in these Guidelines and Part 4, Chapter 4, Section 5 of the Main Rules, as relevant and applicable for auxiliary gears.

5.8.2 When gearboxes, including couplings and shafts, are used for transmitting the braking torque of static or dynamic brakes, they are to have a static strength of at least the braking capacity of the respective brake, as per 5.6 for gearboxes used in winches and 5.7 for gearboxes used in swing circle mechanisms.

5.9 Hydraulic Cylinders

5.9.1 General

.1 Hydraulic cylinders that are used for luffing, folding and telescoping and all other cylinders that are considered as critical, are to be designed, constructed and tested in accordance with the requirements of this Section.

.2 All other cylinders are to be designed to the requirements of the Main Rules.

5.9.2 Design

5.9.2.1 General

.1 Hydraulic cylinders are to be designed to the requirements for pressure vessels as per the Main Rules and the requirements of this Section, taking into account the most severe loading in accordance with Section 2-2.

.2 When more than one cylinder is used for each motion, such as luffing, folding and telescoping, arrangements are to be provided to equalize the pressure and exerted loading among the cylinders. Otherwise, it is to be demonstrated through design analysis that the most severe loading on each cylinder is taken into account for the design of the cylinders.

.3 Materials of hydraulic cylinders are to comply with the requirements of Section 2.

5.9.2.2 Buckling

.1 The critical buckling load on each cylinder is to be at least 2 (two) times greater than the maximum design compressive load on the cylinder in accordance with 5.9.2.1. critical buckling load is to be determined using the appropriate methodology (for e.g. ISO/TS 13725:2021).

5.9.2.3 Lock Valves

.1 Hydraulic cylinders used for luffing, folding or telescoping are to be provided with directly mounted lock valves that are capable of maintaining the position of the cylinder ram in the event of loss of hydraulic power. These valves are to be directly mounted on the cylinders without the use of hoses.

.2 The valves are to be capable of closing automatically when the control lever is returned to the neutral position or upon loss of hydraulic power.

.3 The valves are to have a design rated pressure of at least 1.5 times the pressure induced by the most severe loading in accordance with Section 3. As an alternative, the valves are to be tested to at least 1.5 times the pressure induced by the most severe loading in accordance with Section 3 and a test certificate is to be submitted.

.4 The valves are to be set to hold at least 1.1 times the pressure induced by the most severe loading in accordance with Section 3.

5.9.2.4 Lugs and other Primary Structural Members

.1 Lugs and other primary structural members of hydraulic cylinders are to be designed in accordance with Section 3.

5.9.3 Testing

.1 Each individual unit is to be hydrostatically tested to 1.5 times the maximum allowable working pressure (2 times, for cast iron and nodular iron cylinders) in the presence of the attending Surveyor.

Section 6

Electrical and Control Systems

6.1 Electrical Systems

6.1.1 Electrical systems are to be designed, constructed, installed and tested to the requirements contained in these Guidelines, and Part 4, Chapter 8 of the Main Rules, as relevant and applicable.

6.2 Computer-based Control Systems

6.2.1 Where fitted, computer-based control systems for cranes are to comply with the requirements of Part 4, Chapter 7, (and the sections referenced therein) of the Main Rules, as relevant and applicable, for Category I Systems (Those systems, failure of which will not lead to dangerous situations for human safety, safety of the vessel and/or threat to the environment).

6.2.2 Computer-based control systems of cranes intended for personnel lifting, are to be considered as Category II systems (Those systems, failure of which could eventually lead to dangerous situations for human safety, safety of the vessel and/or threat to the environment).

6.3 Crane Controls, Safety Devices and Features

6.3.1 Cranes are to be fitted with suitable controls, safety devices and features, as indicated in this Section. The same are to be demonstrated to the attending Surveyor (Refer Section 7)

6.3.2 Crane controls are to be clearly marked to show their functions.

6.3.3 Lighting for controls is to be provided.

6.3.4 Control levers for boom hoist, load hoist, swing, folding and telescoping, as applicable, are to return automatically to their center (neutral) positions on release.

6.3.5 Suitable monitoring of the crane's controls is to be provided. As relevant and appropriate, monitoring is to indicate availability of power, air pressure, hydraulic pressure, motor running and slewing brake mechanism engagement.

6.3.6 A boom hoist limiter or shutoff is to be provided to automatically stop the boom hoist when the boom reaches a predetermined high and low angle.

6.3.7 Boom stops are to be provided to resist the boom from falling backwards in a high wind or sudden release of the load. Boom stops should be of one of the following types:

a) Fixed or telescoping bumper;

b) Shock absorbing bumper;

c) Hydraulic boom luffing cylinder(s).

6.3.8 Auxiliary jibs are to be restrained from backward overturning.

6.3.9 A load-moment or load-radius indicating device for main and auxiliary hoists readable from the operator's station is to be provided, preferably with an alarm or audible device to warn the operator of

a possible overload condition; except for cranes designed for same SWL from minimum to maximum radii.
Cranes having different SWLs when operating in different environmental conditions are to be provided with controls to prevent or warn that the maximum hook load is exceeded, without however, overriding the operator's control of the load or crane.

6.3.10 An anti-two block system is to be provided to protect hoist ropes, structural components and machinery from damage.

6.3.11 An audible warning device, within easy reach of the operator, is to be provided. Shipboard cranes, davits, provision cranes, and monorail hoists/engine room overhead cranes, with SWL of less than 25T, may be exempted from this requirement, provided it is determined to the satisfaction of the attending Surveyor that the operator has a clear view throughout the crane operating area.

6.3.12 Aviation warning beacons and spotlights on the boom at night are to be as specified by the Owner.

6.3.13 Cranes are to be provided with an emergency stop system. An emergency stop button is to be located as a minimum at the primary control station. The emergency stop circuit is to be hardwired and independent of any control system signal.

6.3.14 Automatic and manual overload protection systems are to meet the applicable requirements of a recognized industry standard. Electrical, piping and machinery systems are to be in accordance with Section 5 of this document.

6.4 Motion Compensation Systems

6.4.1 General

This Sub-section addresses motion compensation systems that are installed on cranes. This includes passive heave compensation systems and active heave compensation systems.

6.4.2 Design

6.4.2.1 The manufacturer is to specify the design/operational parameters of the motion compensation systems, including any specific operational limitations.

6.4.2.2 Motion compensation systems are to be designed so that a single failure in the system does not cause loss of control of the load. Compliance with this requirement is to be verified by means of a risk analysis (See 6.4.3 below) or equivalent means.

6.4.2.3 When motion compensation systems subject components (such as the sheaves) and ropes to higher fatigue cycles over the lifetime of the crane, the manufacturer is to demonstrate suitability of these components and ropes for the anticipated fatigue cycles. When wire ropes are used, the sheaves and winch drums of motion compensation systems are to have a pitch diameter of not less than 20 times the nominal diameter of the wire rope.

6.4.2.4 The effect of adding a motion compensation system to the crane is to be considered in the design of the crane. This could include additional loading on the structural and/or mechanical components of the crane.

6.4.3 Risk Analysis

6.4.3.1 For motion compensation systems, a risk analysis is to be carried-out for evaluating and mitigating the potential risks associated with the malfunctioning or failure of compensation system components. The risk analysis is to be conducted as per recognized national or international standards.

6.4.4 Structural Members, Machinery, Mechanical Components and Systems

6.4.4.1 Structural members, machinery, mechanical components, piping systems, electrical and control systems used for motion compensation are to meet the applicable requirements of Section 3 of this document and the requirements of this subsection.

6.4.5 Passive Heave Compensation Systems

6.4.5.1 Passive heave compensation systems are to be designed to operate using stored energy.

6.4.5.2 When the passive heave compensation system employs hydraulic/pneumatic stored energy, then the pressure retaining components of the system (such as the accumulators, cylinders, and piping systems) are to be designed for the maximum pressure corresponding to the worst-case anticipated loading on the system, including dynamic loading where applicable.

6.4.5.3 Passive heave compensation system components that are located in the primary load path (such as in-line hydraulic cylinders) are also to be designed to comply with the applicable structural factors of safety of Section 3 of this document, when subjected to the worst-case anticipated loading, including dynamic loading.

6.4.5.4 Passive heave compensation systems utilizing hydraulic/pneumatic cylinders and accumulators are to have a position indicator in order to provide the operator with visual indication of the position of the system with reference to its operating range.

6.4.6 Active Heave Compensation Systems

6.4.6.1 Active heave compensation systems are to be provided with two independent control systems and power supplies. Alternatively, they are to be provided with a back-up means (such as a passive heave compensation system) to prevent shock loading or structural overloading of the crane in the event of failure of the active heave compensation system.

6.4.6.2 Active heave compensation systems are to operate when the boom tip is in the offboard condition. Appropriate means are to be provided to prevent operation of the heave compensation system when the boom tip is in the onboard condition.

6.4.6.3 Appropriate means are to be provided for continuous monitoring and recording of the crane load and load moment during operation of the active heave compensation system.

6.4.6.4 Audio-visual alarms are to be provided for warning the operator in the event of equipment failure or abnormal operation of the active heave compensation system.

6.4.6.5 When computer-based control systems are used for motion compensation systems, they are to comply with the requirements of Part 4, Chapter 7, (and the sections referenced therein) of the Main Rules, as applicable, for Category I Systems.

6.4.6.6 When active heave compensation systems use synthetic fiber ropes, means are to be provided for monitoring the temperature of the rope. The operating temperature of the rope is to be in accordance with the rope manufacturer’s specification. Where there is potential for rope overheating, means are to be provided for cooling the section of rope in-way of the active heave compensation system.

6.4.7 Testing

6.4.7.1 Motion compensation systems are to meet the following testing requirements in addition to Section 7 of this document.

6.4.8 In-Shop Testing

6.4.8.1 Motion compensation systems are to be tested to the satisfaction of the Surveyor in accordance with the manufacturer specified factory acceptance testing requirements.

6.4.8.2 For active heave compensation systems, the testing is to also include simulated testing (such as by using a simulation program to simulate the sensor feedback to the control system) in order to demonstrate the ability of the heave compensation system to maintain the position of the suspended load with reference to a fixed reference frame, under the worst-case operating conditions.

6.4.9 On-Board Functional Testing

6.4.9.1 After installation of the crane on the vessel/offshore facility, the motion compensation systems are to be functionally tested to the satisfaction of the Surveyor in accordance with the manufacturer's testing requirements and approved trial protocols. This functional testing is to be carried out during the initial survey as well as the subsequent surveys, as applicable.

6.5 Rope Tensioning Systems

6.5.1 General

6.5.1.1 This Sub-section addresses rope tensioning systems that are installed on cranes in order to maintain a constant tension on the rope. This includes passive rope tensioning systems and active rope tensioning systems.

6.5.2 Design

6.5.2.1 The manufacturer is to specify the design/operational parameters of the rope tensioning system, including any specific operational limitations.

6.5.2.2 Rope tensioning systems are to be capable of maintaining constant tension on the rope under normal operating conditions of the crane.

6.5.2.3 Rope tensioning systems are to be designed so that a single failure in the system does not cause loss of control of the load. Compliance with this requirement is to be verified by means of a risk analysis (See 6.5.3 below) or equivalent means.

6.5.2.4 When rope tensioning systems subject components (such as the sheaves) and ropes to higher fatigue cycles over the lifetime of the crane, the manufacturer is to demonstrate suitability of these components and ropes for the anticipated fatigue cycles. When wire ropes are used, the sheaves and winch drums of rope tensioning systems are to have a pitch diameter of not less than 20 times the nominal diameter of the wire rope.

6.5.2.5 The effect of adding a rope tensioning system to the crane is to be considered in the design of the crane. This could include additional loading on the structural and/or mechanical components of the crane.

6.5.3 Risk Analysis

6.5.3.1 For rope tensioning systems, a risk analysis is to be carried-out for evaluating and mitigating the potential risks associated with the malfunctioning or failure of tensioning system components. The risk analysis is to be conducted as per the recognized national or international standards.

6.5.4 Structural Members, Machinery, Mechanical Components and Systems

6.5.4.1 Structural members, machinery, mechanical components, piping systems, electrical and control systems used for rope tensioning are to meet the applicable requirements of Section 3 of this document and the requirements of this subsection.

6.5.5 Passive Rope Tensioning Systems

6.5.5.1 Passive rope tensioning systems are to be designed to operate using stored energy.

6.5.5.2 When the passive rope tensioning system employs hydraulic/pneumatic stored energy, then the pressure retaining components of the system (such as the accumulators, cylinders and piping systems) are to be designed for the maximum pressure corresponding to the worst-case anticipated loading on the system, including dynamic loading where applicable.

6.5.5.3 Passive rope tensioning system components that are located in the primary load path are to be also designed to meet the applicable structural factors of safety of Section 3 of this document, when subjected to the worst-case anticipated loading, including dynamic loading where applicable.

6.5.5.4 Passive rope tensioning systems are to have a position indicator to provide the operator with visual indication of the position of the system with reference to its operating range.

6.5.6 Active Rope Tensioning Systems

6.5.6.1 Active rope tensioning systems are to be provided with two independent control systems and power supplies. Alternatively, they are to be provided with a backup means (such as a passive rope tensioning system) to prevent shock loading or structural overloading of the crane in the event of failure of the active rope tensioning system.

6.5.6.2 Active rope tensioning systems are to operate when the boom tip is in the offboard condition. Appropriate means are to be provided to prevent operation of the active rope tensioning system when the boom tip is in the onboard condition.

6.5.6.3 Appropriate means are to be provided for continuous monitoring and recording of the crane load and load moment during operation of the active rope tensioning system.

6.5.6.4 Audio-visual alarms are to be provided for warning the operator in the event of equipment failure or abnormal operation of the active rope tensioning system.

6.5.6.5 When computer-based control systems are used for active rope tensioning systems, they are to comply with the requirements of Part 4, Chapter 7, (and the sections referenced therein) of the Main Rules, as applicable, for Category I Systems.

6.5.6.6 When active rope tensioning systems use synthetic fiber ropes, means are to be provided for monitoring the temperature of the rope. The operating temperature of the rope is to be in accordance with the rope manufacturer's specification. Where there is potential for rope overheating, means are to be provided for cooling the section of rope in-way of the rope tensioning system.

6.5.7 Testing

6.5.7.1 Rope tensioning systems are to meet the following testing requirements in addition to Section 7 of this document:

6.5.8 In-Shop Testing

6.5.8.1 Rope tensioning systems are to be tested to the satisfaction of the Surveyor in accordance with the manufacturer specified factory acceptance testing requirements. For active rope tensioning systems, the testing is to also include simulated testing that demonstrates the ability of the tensioning system to maintain constant rope tension, under the worst-case operating conditions.

6.5.9 On-Board Functional Testing

6.5.9.1 After installation of the crane on the vessel/offshore facility, rope tensioning systems are to be functionally tested to the satisfaction of the Surveyor in accordance with the manufacturer's testing requirements and approved trial protocol. This functional testing is to be carried out during the initial survey as well as the subsequent retesting surveys.

Section 7

Surveys

7.1 General

7.1.1 All cranes, including all accessory gear, are to have been satisfactorily tested and examined by the crane manufacturer and/ or the Surveyor, as applicable, depending on the type of component/ equipment, before being put to onboard use. The person performing the testing and examination is to be duly authorized by the manufacturer.

7.1.2 The Surveyor will witness tests at works and during FATs, Initial, Annual, Special and Damage Surveys.

7.1.3 The particulars of these tests and examinations will be entered on the applicable certificate and inserted in the Lifting Appliances Register.

7.2 Surveys during Construction

7.2.1 General

7.2.1.1 All cranes are to be surveyed during construction. Surveys of cranes during construction are required to the extent necessary for the Surveyor to determine that the details, material, welding and workmanship are acceptable to IRS and are in accordance with the approved drawings, documentation and trial protocols.

7.2.1.2 The Surveyor is to have access to all material test certificates. All testing at works of the crane structural components or assembled cranes is to be witnessed and reported on by the attending Surveyor.

7.2.1.3 The survey during construction report is to identify all members of the crane that have thickness less than 6 mm and where special protective coatings were applied.

7.2.1.4 Load testing of the crane unit is to be carried out as per 7.3, as relevant, in the presence of surveyor.

7.2.1.5 Nondestructive testing is to be carried out in accordance with Section 2, 2.8 to the satisfaction of the attending Surveyor.

7.2.2 Quality control system

7.2.2.1 The manufacturer is to establish and maintain a quality control system to assure that all requirements, including design approval, materials, verification, fabrication workmanship and nondestructive testing, are complete.

7.2.2.2 The quality control system should provide sufficient details of manufacturing and inspection to assure that manufacturer’s inspections are performed at appropriate stages of fabrication. In the event of noncompliance, fabrication should be delayed for rectification.

7.2.2.3 The quality control system should fully document welding procedures and qualification of welding personnel. The quality control system should also detail the procedures and qualifications of nondestructive testing personnel to be employed in all stages of fabrication and manufacture.

7.2.2.4 The manufacturer's quality control system should provide assurance that required heat treatments have been performed.

7.2.2.5 The manufacturer is to submit the documents supporting the above 7.2.2.1 to 7.2.2.4 for review.

7.2.3 Slewing Ring Surveys

7.2.3.1 Surveys at the works of the slewing ring manufacturer are required in order to verify that the following items are in accordance with the requirements of these Guidelines and the approved drawings:

i) Material test certificates and documentation.

ii) Dimensions of components.

iii) Hardness, heat treatment, and material properties of each bearing ring and rollers.

iv) Planarity (flatness) tolerances and surface finish.

v) Verify that openings and corners in way of the raceway have a smooth machined radius in accordance with manufacturer's specifications.

vi) Final fit-up of assembled slew bearing.

vii) Witness manufacturer's acceptance testing.

7.2.3.2 For slewing rings manufactured using welded construction, in addition to the above requirements, the following will also apply:

i) Welding procedure specifications and corresponding weld procedure qualification records to the extent deemed necessary by the attending Surveyor.

ii) Welder's qualifications to the extent deemed necessary by the attending Surveyor.

iii) Fit-up prior to major weldments.

iv) Final weldments.

v) Nondestructive Testing (NDT) of welds and records of NDT.

7.2.3.3 Hardened raceways are to be hardness tested in at least eight locations equally distributed along the circumference and the hardness values are to be within the range specified by the manufacturer. Evidence demonstrating that the hardness depth criteria have been met is to be furnished to the attending Surveyor.

7.2.4 Certification during Construction

7.2.4.1 Upon satisfactory fabrication, the Surveyor may issue a certificate certifying that the crane has been built in accordance with these requirements, the extent of testing witnessed, and showing the model and serial numbers, a description of the crane, and the date of issue.

7.3 Testing Cranes as a Unit

7.3.1 Test Loads

7.3.1.1 The crane is to be tested onboard to the following proof loads:

.1 Shipboard and Heavy Lift Cranes (For SWL of assembled crane at the specified working radius)

a) SWL ≤ 20 t: 25% in excess of SWL

b) 20t < SWL ≤ 50t: SWL + 5t

c) SWL > 50t: 10% in excess of SWL

.2 Offshore Cranes (For SWL of assembled crane at the specified working radius)

i) Initial Proof Load Test (Test of the crane after installation on board prior to first use and performed within a harbor or sheltered area or in very mild environmental conditions.)

a) SWL ≤ 20 t: 25% in excess of VL

b) 20t < SWL ≤ 50t: VL + 5t

c) SWL > 50t: 10% in excess of VL

VL = 0.75×DAF×SWL, where DAF is the dynamic amplification factor. For the purposes of this Section, DAF is not to be taken less than 1.33.

ii) Load Testing Subsequent to Initial Proof Load Test

a) SWL ≤ 20 t: 25% in excess of SWL

b) 20t < SWL ≤ 50t: SWL + 5t

c) SWL > 50t: 10% in excess of SWL

7.3.1.2 Proof load is not to be less than the overload protection (shutdown) setting of the crane.

7.3.1.3 The Initial proof load need not exceed the design load of the hoisting winch brakes calculated as per 5.6.3.

7.3.2 Proof Testing and Inspection

7.3.2.1 General

7.3.2.1.1 The purpose of the Proof Test is to test the crane in the most severe loading conditions.

7.3.2.1.2 Proof testing requirements for all cranes is as follows:

i) For complex cranes, such as knuckle boom cranes, level luffing cranes and other multiple boom cranes, the following conditions are to be taken into consideration when choosing test locations:

a) Maximum overturning moment

b) Boom buckling and suspension

c) Boom hydraulic cylinder buckling

d) Hoist wire breaking strength

ii) For fixed boom cranes without approved proof test procedures, the crane is to be tested at least at the minimum, intermediate, and maximum radii.

7.3.2.1.3 The manufacturer is to identify proof load testing conditions based on most severe loading on each crane component and a general procedure that identifies the ranges of weights and radii that will test the crane in each identified condition is to be submitted for approval.

7.3.2.2 Proof Testing

7.3.2.2.1 General

.1 The test radii are to be stated on the Certificate of Test together with the proof loads used.

.2The proof load is to be lifted and held for at least five minutes.

.3 The Proof Test is to also include a function test of all safety features, fail-safe and limitingdevices, load-moment and boom-angle indicators, and optional systems.

.4 The Proof Test is to include hoisting and lowering of the main hook, auxiliary hook and boom; slewing (swinging) and luffing with the proof test load on the hook, to the extent possible as noted below:

7.3.2.2.2 Cranes with Design Restrictions

.1 For Offshore cranes with Proof Test loads calculated using a dynamic amplification factor, DAF, greater than 1.33, the Proof Test load should only be luffed and not hoisted nor slewed unless the manufacturer confirms that the crane design is rated for it.

.2 For cranes when there is a built-in load limiting control or system and it is not possible to hoist the required proof-load, the proof load may be luffed or lifted by means other than hoisting. The built-in load limit control or system is not to be adjusted to hoist the proof load.

.3 For cranes when there is a built-in load limiting control or system and it is not possible to slew the required proof-load, the crane is to slew a test load not less than the safe working load stated on the certificate. The built-in load limit control system is not to be adjusted to slew the proof load.

.4 For cranes on floating structures where proof-load testing can create vessel inclinations greater than the rated design conditions, it is acceptable to test the slew the maximum load possible at inclinations no greater than those conforming with 5.7.1. In these cases, the proof load is to be lifted with the slew brakes set at conditions no greater than those conforming with 5.7.3.

7.3.2.2.3 Initial Proof Load Test of Cranes

.1 Unless otherwise approved and as specified, the Initial Proof Load Test is to be carried out using movable known weights.

7.3.2.2.4 For Testing of Cranes Subsequent to the initial Test

.1 In the case of cranes when there is built-in load limiting control or system and it is not possible to lift the required proof-load, it will be sufficient to lift the greatest possible load. However, in no case is the test load to be less than the safe working load stated on the certificate.

Note: When the load lifted is less than the required proof test load, a notation is to be made on the certificate that this load was the maximum possible load and that the adjusting devices or relief valves were found sealed.

7.3.2.2.5 Testing of Derrick Systems (Conventional Cargo Gear)

.1 Unless otherwise approved, the proof load is to be applied by hoisting movable weights with the cargo boom at an angle to the horizontal which is to be stated in the certificate of the test. This angle is not to be greater than 15 degrees to the horizontal for loads up to and including 10 tons and 25 degrees for loads above 10 tons, or the lowest angle approved in association with the design, or when these angles are impracticable, at the lowest practicable angle. After the proof load has been lifted, it is to be swung as far as possible in both directions. After being tested as aforesaid, all cargo gear, with the whole of the gear accessory thereto, and all chains, rings, hooks, links, shackles, swivels, pulley blocks or other loose gear is to be examined to see whether any part has been damaged or permanently deformed by the test.

.2 For union purchase, the proof load is to be applied by hoisting movable weights and is to be rigged as shown on the approved plans. The proof load is to be lifted to the approved hook height above the deck in such a manner that all the load is taken by one runner, then transferred along a path parallel to the deck until it reaches the other boom and the entire load is taken by the runner which had been slack. After being tested as aforesaid, the gear is to be rigged so that the inboard (hatch) boom will become the outboard (shore) boom and vice versa. The test is to then be repeated.

7.3.2.3 Post-test Examination after Proof Testing

7.3.2.3.1 After being tested, each lifting appliance, together with all critical accessories, is to be examined to see whether any part has been damaged or permanently deformed by the test. In addition to the list of structural components listed in Section 2, the Surveyor is to visually examine (including NDE if required) at least the following items:

i) Foundation

ii) Sheaves and rope guides

iii) Wire ropes including end connections

iv) Hoist machinery, brakes and clutches

v) Hooks. For offshore and heavy lift cranes, as well as cranes used for personnel lifting, the hooks are to be also non-destructively examined using suitable crack detection methods

vi) Slewing assembly and bolting arrangements

vii) Boom heel pins and brackets

Upon completion of proof load testing, in addition to the items above, the slew ring, including bolting arrangements and foundation, is to be examined for slack bolts, damaged bearings, and deformed or fractured weldments. Pretensioning of slew ring bolts is to be verified as required by the manufacturer ’ s onboard documentation. Any bolts found to be suspect by the Surveyor are to be removed and examined by NDE. Critical welds of the pedestal and deck connections are to have random NDE conducted to the satisfaction of the attending Surveyor.

7.3.3 Source of Electrical Power

7.3.3.1 Current for electrical winch operation during the test is to be taken through the vessel’s cables. Shore current may be used when supplied through the main switchboard.

7.3.4 Brakes and Fail-safe Devices

7.3.4.1 The operation of all brakes and fail-safe devices is to be demonstrated under simulated loss of power conditions to the satisfaction of the Surveyor. The crane manufacturer is to prepare a test memorandum outlining the cautions and procedures for proper testing of the devices.

7.3.5 Machinery

7.3.5.1 General examination of machinery, piping and electrical equipment. See Section 5 and 6.

7.3.6 Marking of Assembled Lifting Appliance

7.3.6.1 The safe working load (SWL) and other information essential for the safe operation of the lifting appliance (e.g. maximum or minimum slewing radius or boom angle) should be permanently and clearly marked in a conspicuous place on the lifting appliance and should be available to the operator.

7.3.6.2 In all cases where the lifting appliance has a variable load radius rating, the SWLs corresponding to the minimum and maximum radius should be clearly marked in a conspicuous place on the lifting appliance and, in addition, a diagram of the permissible maximum loads over the entire range of use should be displayed in a position clearly visible to the operator.

7.3.6.3 For single rated booms, the Safe Working Load (abbreviated “SWL”) for the assembled crane is to be marked on the legs of gantry cranes and on the heel of jib crane booms together with the minimum angle to the horizontal or radius and date of test for which the boom is certified. These letters and figures are to be in contrasting colors to the background and at least one inch in height.

7.3.6.4 Where the crane is approved for varying capacities, crane capacity rating chart indicating the maximum safe working loads are to be conspicuously posted near the controls and visible to the operator when working the gear. These charts should indicate the various working angles of the boom and the maximum and minimum radii at which the boom may be safely used, for each boom length intended. See 3.1.2.

7.3.6.5 The Safe Working Load for union purchase, SWL (U), for the assembled gear is to be marked on the heel of each of the booms in contrasting colors to the background, with the date of test. Letters and numbers are to be at least 25 mm high.

7.3.7 Record of Test

7.3.7.1 Copies of the initial and subsequent certificates of tests issued by the Surveyor are to be inserted in the Lifting Appliances Register.

7.4 Initial Survey

7.4.1 General

7.4.1.1 During the Initial Survey, the Initial proof testing and examination should be conducted in accordance with 7.3 and the test conditions and results should be included in the Lifting Appliances Register.

7.4.1.2 Verification of relevant documentation is to be carried out.

7.4.2 Cranes with Slewing Rings

7.4.2.1 For cranes fitted with slewing rings, prior to mounting of the crane, the Surveyor is to witness flatness checks and surface finish requirements to verify compliance with the manufacturer’s specifications for the following:

i) Crane attachment area for slewing ring.
ii) Slewing ring.
iii) Mounting flange on pedestal.

7.4.2.2 Shimming or surface leveling compounds are not to be used to attain the required level of flatness of the mounting surfaces.

7.4.2.3 During installation, bolts are to be pretensioned by controlled means. Pre-tensioning, by bolt torque or by hydraulic tensioning device, is to be in accordance with the bearing manufacturer’s instructions, which are to be submitted for review. Elongation of the bolts is to be measured to verify pre-tensioning. At least 10 percent of the bolts, randomly selected, are to be measured to the satisfaction of the attending Surveyor.

7.4.2.4 Once the crane has been installed on-board, a “Rocking Test” taken in accordance with the bearing manufacturer’s instructions is to be conducted and the results are to be included in the Lifting Appliances Register.

7.4.3 All Cranes

7.4.3.1 The critical welds of crane pedestals or kingposts are to be subjected to the following nondestructive testing to the satisfaction of the attending Surveyor, prior to proof testing:

a) 100% volumetric NDT of all critical butt welds in the crane pedestals or kingposts, including any transition pieces between the pedestal and crane slewing ring.

b) 100% surface NDT on both sides of critical fillet welds in the pedestal or kingpost and transition pieces.

7.4.3.2 A load rating vs. boom angle chart with clearly legible letters and figures on durable material is to be securely fixed to the crane in a location easily visible to the operator. Where more than one boom length is supplied, or where more than one rating is applicable to a boom (e.g., static rating and dynamic rating), a chart should be supplied for each. See 7.3.6.

7.4.3.3 For cranes with telescoping booms, it is to be demonstrated that the sequence of telescoping is such that the thickest boom sections are extended first.

7.4.3.4 After proof load testing, at least 10% random surface NDT on both sides of critical welds, such as circumferential welds, in the pedestal, kingpost, and transition pieces is to be carried out to the satisfaction of the attending Surveyor.

7.4.3.5 For cranes that are to be certified for lifting of personnel, all applicable requirements for personnel lifting of Section 8.1 are to be examined and verified. All safety devices and features are to be tested and personnel emergency recovery, performed in accordance with the submitted manufacturer's procedures, is to be demonstrated to the attending Surveyor.

7.4.3.6 Where cranes are installed on a vessel or offshore unit during new construction and are placed in service before delivery of the vessel or offshore unit, a repeat load test in accordance with 7.3 will be required to be carried out 30 days prior to delivery of the vessel or offshore unit.

7.4.3.7 In addition to the Proof Load Testing, initial survey is to include confirmatory testing to demonstrate the dynamic braking effectiveness. Dynamic braking is to be tested by cycling the luffing, hoisting and folding drives, as applicable, at their rated load and corresponding maximum speeds, over a sufficient range of motion for a period of at least 5 minutes.

7.4.3.8 Upon satisfactory completion of survey and testing after installation, a Register of Lifting Appliances may be issued which will also contain the works testing certificates and reports.

7.4.4 Motion Compensation Systems On-Board

7.4.4.1 Motion compensation systems are to be functionally tested to the satisfaction of the Surveyor in accordance with the manufacturer's testing requirements and approved trial protocol. This functional testing is to be carried out during subsequent retesting surveys. This testing need not be conducted to the maximum safe working load of the crane.

7.4.5 Rope Tensioning Systems On-Board

7.4.5.1 Rope tensioning systems are to be functionally tested to the satisfaction of the Surveyor in accordance with the manufacturer's testing requirements and approved trial protocol. This functional testing is to be carried out during subsequent retesting surveys. This testing need not be conducted to the maximum safe working load of the crane.

7.5 Periodical Surveys

7.5.1 Annual Surveys

7.5.1.1 General

7.5.1.1.1 Each crane is required to undergo an Annual Survey. Surveys of cranes subject to certification in accordance with ILO requirements are to be at intervals of 12 months. Surveys of cranes not subject to certification in accordance with ILO requirements may be made within three months before or after each anniversary date of the crediting of the previous Initial or renewal survey when requested by the owner. The Administration may require examinations at intervals of 12 months.

7.5.1.1.2 The Annual Survey is to include the following:

a) Visual inspection of the crane structure for deformation, excessive wear, corrosion, damage or cracks/ fractures, as necessary. The boom is to be lowered for this examination. Design requirements for cranes do not include a wastage allowance. Any wastage found requires submittal to IRS prior to acceptance.
b) Visual examination of crane hooks for deformation, excessive wear or cracks/ fractures.
c) For offshore and heavy lift cranes, as well as cranes used for personnel lifting, the hooks are to be also non-destructively examined using suitable crack detecting inspection methods.
d) Visual external examination of machinery, piping and electrical equipment and operational test of crane machinery including prime mover, clutches, brakes; hoisting, slewing and luffing machinery.
e) Visual inspection of wire rope including end attachments.
f) The slewing ring, where applicable, is to be examined for slack bolts, damaged bearings and deformation or fractured weldments. Rocking Tests, in accordance with the bearing manufacturer's instructions, are to be taken every six months. The results of these tests are to be recorded in the Lifting Appliances Register for review by the attending Surveyor at each annual survey.
g) Functional tests including main and auxiliary load hoisting and lowering, boom raising and lowering, slewing (swinging), safety protective (fail-safe) and limiting devices and load and boom angle or radius indicators.
h) If the crane is certified for lifting of personnel, examination and verification of all the applicable requirements for personnel lifting in accordance with Section 8.1. All safety devices are to be tested and personnel emergency recovery, performed in accordance with the submitted manufacturer's procedures, is to be demonstrated to the attending Surveyor.
i) For single rated booms, the SWL for the assembled gear is to be marked on the legs of gantry cranes and on the heel of jib crane booms together with the minimum angle to the horizontal or radius and date of test for which the boom is certified. These letters and figures are to be in contrasting colors to the background and at least one inch in height. Where the crane is approved for varying capacities, crane capacity rating chart indicating the maximum safe working loads are to be conspicuously posted near the controls and visible to the operator when working the gear. These charts should indicate the various working angles of the boom and the maximum and minimum radii at which the boom may be safely used, for each boom length intended. The Safe Working Load for union purchase, for the assembled gear is to be marked on the heel of each of the booms in contrasting colors to the background, with the date of test. Letters and numbers are to be at least 25 mm high.
j) Verification that the maintenance and inspection plan for ropes is being followed.
Note: The crane owner or operator is to establish and document a wire rope maintenance and inspection program taking into consideration the crane type, frequency of usage, history of maintenance, wire rope manufacturer's recommendations and crane manufacturer's recommendations. (For additional guidance on wire rope maintenance and inspection, refer to API RP 2D, ISO 4309:2017, or equivalent recognized national or international standards.) The crane owner or operator is to examine the wire rope, including end connections, annually as a minimum. Inspection and maintenance records are to be maintained on board the vessel by the crane owner or operator and are to be made available to the Surveyor during surveys. All running wire ropes are to be visually inspected at each Annual and Retesting Survey. Wire rope

inspection and discard requirements during surveys are to be in accordance with Section 6 of ISO 4309:2017 (Discard Criteria) or equivalent recognized national or international standards

7.5.1.2 Subsea Cranes

7.5.1.2.1 For subsea lifting, the crane is to meet the following testing requirements in addition to in addition to the annual survey general requirements stated above.

7.5.1.2.2 Functional Testing

a) The crane is to be functionally tested to the satisfaction of the Surveyor and in accordance with the crane manufacturer's recommendations. This functional testing is to be carried out during the initial survey as well as the subsequent renewal surveys.

b) Functional testing is to include lowering the SWL to the rated vertical depth (of the crane for subsea lifting) and retrieval of the SWL from the rated vertical depth. Where this is not practicable, consideration may be given to the following on a case-by-case basis:

i) Lowering of the SWL to the maximum available water depth in the vicinity of the vessel/ unit's location
or
ii) Simulated test using a constant tension winch or traction winch to replicate the SWL.

c) Functional testing is to also include verification of the rope spooling capability of the load hoisting winch, when there is no load on the hook.

7.5.1.2.3 Hook and Block Examination

a) Hooks and blocks used for subsea lifting are to be opened up, examined and non-destructively tested annually in the presence of a Surveyor.

7.5.1.2.4 Running Rope Maintenance and Inspection Plan

a) The crane owner or operator is to establish and document a rope maintenance and inspection schedule for running ropes used for subsea lifting. The maintenance and inspection schedule is to consider the type of rope, operating and environmental conditions, loading regime, lifting system configuration, and manufacturer's recommendations. The schedule should address the rope inspection, rope NDE, rope monitoring, rope lubrication, rope breaking strength testing and rope discarding and replacement. Rope inspection and maintenance records, including lubrication, NDE and breaking strength testing records, are to be maintained on board the vessel and are to be made available to the Surveyor upon request. If the wire rope maintenance program is found to be ineffective, the Surveyor may require the wire rope to be examined using magnetic rope testing or that a sample of the rope be removed and subjected to break testing.

For additional guidance on rope maintenance and inspection, refer to IMCA M194, IMCA SEL 022, IMCA LR 001, IMCA LR 004, ASME B30.30:2019 or equivalent recognized national or international standards. Additionally, the following guidance may be considered by the owners/operators:
i) It is recommended that the baseline condition of the rope be established using NDE techniques, such as Magnetic Rope Testing, at the time of installation of the rope on the crane. Thereafter, NDE at periodic intervals can allow the tracking of the condition of the rope over its service life, and can assist in detecting rope damage.
ii) A condition monitoring program that tracks the rope condition, utilization (especially for sections in way of sheaves during heave compensation), temperature, critical geometric parameters, and fatigue life may be employed in order to optimize the service life.
iii) Where applicable, the wire rope should be lubricated as per the manufacturer's specifications before being put into use and periodically thereafter. The lubrication procedure is to achieve adequate lubricant penetration to the interior of the rope and is to provide a proper service dressing on the exterior of the rope. Particular attention should be paid to the lubrication of those rope sections that pass through and around sheaves, and those that are immersed in

salt water while conducting subsea operations and experiencing active heave compensation conditions. Where recommended by the rope manufacturer, the pressure lubrication method may be used. Otherwise, suitable lubrication methods such as spreading or brushing may be employed. The lubricant used on ropes should be as per the rope manufacturer's recommendations and should be suitable for the intended application.

iv) For new wire rope and wire rope not used for extended periods, a baseline inspection of the entire rope and break strength testing of a sample should be conducted when (re-)entering operation.

v) Break strength testing of a sample of the rope at periodic intervals is recommended in order to verify that the rope strength continues to meet the design requirements of this Guide. The standard used for break strength testing should be cited in the test report. Since the test results may be affected by the sample preparation techniques, transportation and testing processes, due care should be taken so that the sample is not compromised.

vi) The rope discarding and replacement criteria should be established in accordance with the rope manufacturer's instructions or industry recognized standards and Operator's past experience of similar lifting appliance systems. For ropes which show signs of deterioration but do not yet meet the discard criteria, their upcoming inspection intervals and scope should be evaluated for adjustment.

vii) Exchanging of the rope ends may be considered to even out utilization of the rope sections. Where used, it is recommended that the exchanging be carried out around the midpoint of the service life of the rope.

viii) Cutting back and discarding of the most used section of the rope can be considered. Care should be taken when cutting and reterminating the rope, and the manufacturer's instructions or recognized standards should be followed.

ix) Fresh water rinse and drying of a wire rope should be conducted before re-lubrication, and between extended out-of-service periods.

b) The service life of ropes is to be evaluated on the basis of manufacturer's recommendations, operational factors known to reduce the life of ropes and periodic inspections in accordance with the rope maintenance and inspection program. It is the responsibility of the operator to replace damaged ropes or ropes that have reached the end of their service life. (For subsea lifting, the service life of the ropes will vary significantly depending on operational factors such as the reeving arrangement, number of duty cycles, rope temperature, ingress of salt water within the rope core, corrosion, wear, mechanical damage, etc. It may be noted that the use of active heave compensation systems often leads to accelerated fatigue damage due to repeated bending cycles over multiple sheaves and increased temperature of the ropes.)

7.5.1.3 Motion Compensation Systems On-Board

7.5.1.3.1 Motion compensation systems are to be functionally tested to the satisfaction of the Surveyor in accordance with the manufacturer's testing requirements and approved trial protocol. This functional testing is to be carried out during subsequent retesting surveys. This testing need not be conducted to the maximum safe working load of the crane.

7.5.1.4 Rope Tensioning Systems On-Board

7.5.1.4.1 Rope tensioning systems are to be functionally tested to the satisfaction of the Surveyor in accordance with the manufacturer's testing requirements and approved trial protocol. This functional testing is to be carried out during subsequent retesting surveys. This testing need not be conducted to the maximum safe working load of the crane.

7.5.2 Renewal Surveys

7.5.2.1 General

.1 At intervals of five years, in addition to the requirements of the Annual Survey above, the crane is to undergo proof testing and examination in accordance with 7.3..

.2 The Renewal Surveys of cranes not subject to certification in accordance with ILO requirements may be extended a single time by three months if found in satisfactory condition by a Surveyor.

7.5.2.2 Cranes

.1 Requirements Prior to Load Testing

a) For all Cranes, Surveyor is to witness a Rocking Test. The Rocking Test is to be performed in accordance with the bearing manufacturer's recommendations or procedures. If the results of the Rocking Test indicate potential bearing wear in excess of the manufacturer's recommendation, the bearing is to be opened for internal examination or replaced.

b) For all cranes, a grease sample is to be taken from the slew ring bearing for analysis. The grease sample is to be obtained and analyzed in accordance with the slew ring bearing manufacturer's recommendations. In the absence of other methods, the grease analysis for particulates is to be performed as per ASTM D1404:2019. If the results of the grease samples indicate potential bearing wear in excess of the manufacturer's recommendation, the bearing is to be opened for internal examination or replaced.

.2 Additional Requirements for Shipboard and Heavy Lift Cranes which operate within a harbour or sheltered area under mild environmental conditions.(0.5m wave height)

a) Cranes fitted with slew ring bearings are to undergo the following tests and examinations:

i) Cranes 18 ≤ Age < 21 Years Old : 10 percent of the slew ring bolts are to be removed and nondestructively tested.

ii) Cranes 21 Years and Older : 25 percent of all slew ring bolts are to be removed and nondestructively tested.

The quantity of bolts subjected to nondestructive testing may be based on the age of the bolts rather than the age of the crane, if satisfactory evidence of the bolt age is provided to the attending Surveyor. Bolts chosen for examination are to be taken from the most highly-loaded area of the slew ring, and their position is to be noted for future surveys. If any bolts are found with defects, additional bolts are to be removed to confirm suitability for continued use. Alternative methods of testing of the slew ring and bolts may be specially considered. Manufacturer's recommendations for bolt specifications are to be followed. All bolts removed, whether replaced or reinstalled, are to be tested and the reports provided to the attending Surveyor. (Refer 7.4.2.3)

.3 Additional Requirements for Offshore Cranes and Heavy Lift Cranes which operate in open sea in environmental conditions other than mild and certified in accordance with Section 8.1.

a) The critical welds of offshore crane pedestals or kingposts are subject to the following nondestructive testing to the satisfaction of the attending Surveyor:

i) Volumetric NDT of all critical butt welds in the crane pedestals or kingposts, including any transition pieces between the pedestal and crane slew ring. This may be omitted if both sides are accessible and 100% volumetric NDT has been previously completed in the crane's records.

ii) 100% surface NDT on both sides of critical butt and fillet welds in the pedestal or kingpost and transition pieces.

b) Offshore Cranes fitted with slew ring bearings are to undergo the following tests and examinations:
i) Cranes 5 < Age ≤ 10 Years Old. 10 percent of the slew ring bolts are to be removed and nondestructively tested.
ii) Cranes 10 < Age ≤ 15 Years Old. 15 percent of the slew ring bolts are to be removed and nondestructively tested.
iii) Cranes 15 < Age ≤ 20 Years Old. 20 percent of the slew ring bolts are to be removed and nondestructively tested.

iv) Cranes > 20 Years Old. 25 percent of all slew ring bolts are to be removed and nondestructively tested.

The quantity of bolts subjected to nondestructive testing may be based on the age of the bolts rather than the age of the crane, if satisfactory evidence of the bolt age is provided to the attending Surveyor. Bolts chosen for examination are to be taken from the most highly-loaded area of the slew ring, and their position is to be noted for future surveys. If any bolts are found with defects, additional bolts are to be removed to confirm suitability for continued use. Alternative methods of testing of the slew ring and bolts may be specially considered. Manufacturer's recommendations for bolt specifications are to be followed. All bolts removed, whether replaced or reinstalled, are to be tested and the reports provided to the attending Surveyor.

.3 Cranes with options for boom length, reeving configurations or hook blocks are to be tested in the configurations specified by the Manufacturer/ Owner using the approved load charts, approved trial protocols and documented in the record of test. The crane is to be tested and examined onboard as per 7.3 . Proof load is not to be less than the overload protection (shutdown) setting of the crane. Copies of the initial and subsequent certificates of tests issued by the Surveyor are to be inserted in the Lifting Appliances Register.

7.5.4 Repairs and Alterations

7.5.4.1 Crane Structure, Booms and Permanent Fittings

7.5.4.1.1 When repairs or renewals, including welding and or replacement of major structural components are required to be made to the load bearing structures or permanent fittings of cranes, IRS is to be informed well in advance and repairs are to be carried out to the satisfaction of the Surveyor. Any welding is to be done in accordance with an approved procedure. Examination and testing of the crane are to be carried out in accordance with 7.5.3.

7.5.4.1.2 When modifications are carried out proof load testing may be required in accordance with the 7.3.

7.5.4.1.3 Crane load ratings are not to be reduced based on damage or wastage. Examples of load bearing structures requiring retest are:

i) Booms, or jibs including chords and lacing
ii) Center post, gantry, mast, "A"-frame, or back leg
iii) Pedestal or kingpost
iv) Foundation
v) Revolving upper structure
vi) Swing circle (slew bearing) assembly
vii) Pins and shafts
viii) Eye plates and brackets

7.5.4.2 Repairs to Loose Gear

7.5.4.2.1 Welding is not to be used to lengthen, alter or repair chains, hooks, links, shackles or swivel.

Section 8

Additional Features

8.1 Personnel Lifting

8.1.1 General

8.1.1.1 Cranes intended to be certified for lifting or moving of personnel are to be equipped with the specific features given in the subsequent paragraphs, in addition to other requirements of these Guidelines.

8.1.2 Personnel Rated Loads

8.1.2.1 For lifting appliances used for both non-personnel and personnel lifting, the personnel SWL rating is not to exceed fifty percent (50%) of the corresponding non-personnel SWL rating.

8.1.2.2. For lifting appliances dedicated to lifting of personnel, the load to be considered in the design and analysis of such appliances is to be twice the personnel SWL rating.

8.1.2.3 The personnel SWL ratings of the crane are to be indicated on the crane capacity rating chart for all personnel lifting working radii, significant wave heights and wind velocities. The personnel net or basket is to be considered part of the rated load.

8.1.3 Personnel Hoist System

8.1.3.1 Load blocks used for personnel lifting are to be permanently marked with the maximum SWL to be used for lifting personnel.

8.1.3.2 Load blocks used for both non-personnel and personnel lifting are to be permanently marked with both the maximum non-personnel SWL and personnel SWL.

8.1.3.3 Load blocks dedicated to lifting of personnel are to be designed for a load at least twice the personnel SWL.

8.1.3.4 The hooks used for personnel lifting are to be provided with latches fitted with positive locking means, whereby inadvertent opening of the latch is prevented. A locking device and/or an arrangement which operates under a retaining spring force is not considered as a positive locking means as the latch may inadvertently open due to vibrations during operations, due to a failure of the retaining spring, etc. The latch is not intended to support the lifted load.

8.1.3.5 Loose gear dedicated to lifting of personnel are to be tested for a safe working load at least twice the proof load indicated in Section 4.

8.1.4 Winch Brakes

8.1.4.1 Hoisting and luffing winches used for lifting of personnel are to be equipped with at least a static and a dynamic brake, which are to be mechanically and operationally independent, with separate control circuits.

8.1.4.2 Each brake is preferably to act directly on the winch drum but a fully independent load path will be considered on a case-by-case basis.

8.1.4.3 Means are to be provided for the user to conduct an individual test of each brake.

8.1.4.4 The brakes used only for lifting of personnel are to fulfill the requirements given in 5.6.3, except that the Live Load is to be based on the Personnel SWL, when calculating the applicable line pull force.

8.1.5 Cylinders

8.1.5.1 Where cylinders are used for luffing, folding or telescoping, each motion is to be provided with one of the following:

.1 One cylinder with double seals at the piston head and rod.

.2 Two independent cylinders, where each cylinder is to be independently capable of holding the rated capacity for personnel lifting.

8.1.6 Mode Selection for Personnel Lifting

8.1.6.1 Where cranes are fitted with any of the following systems and the hoisting and/or luffing system is commonly used for both personnel and non-personnel lifts, the control station is to be equipped with a manual switch for selection between cargo and personnel lifting modes. The switch is to have a warning light continuously illuminating when personnel lift mode is activated. Means are to be provided to prevent inadvertent change between modes. Such means do not include posted instruction plates or placards.

- Automatic Overload Protection Systems (AOPS)
- Manual Overload Protection Systems (MOPS)
- Active Heave Compensation Systems
- Active Rope Tensioning Systems
- Passive Heave Compensation Systems
- Passive Rope Tensioning Systems

8.1.6.2 When the mode for personnel lifting is selected, the following functions are to be maintained:

.1 All brakes are to be automatically activated when the controls are in neutral position and in case of emergency stop being activated or in the event of power failure.

.2 Where fitted, all automatic overload protection systems (AOPS) and manual overload protection systems (MOPS) are to be overridden and locked out.

.3 Where fitted, active heave compensation systems, active rope tensioning systems, passive heave compensation systems and passive rope tensioning systems are to be overridden and locked out.

8.1.7 Personnel Emergency Recovery

8.1.7.1 General

8.1.7.1.1 Cranes are to be fitted with an emergency recovery system in compliance with the requirements of this subsection.

8.1.7.2 Emergency Recovery System for PER notation

The crane is to be fitted with its own independent means for controlled luff down and lowering operations in the event of a single failure in the power or control system. Such means are to provide controlled lowering and stopping of the winch drums and cylinders under all load conditions.

8.1.7.3 Emergency Recovery System for PER+ notation

The crane is to be fitted with its own independent means for controlled slew, luff down, and lowering operations in the event of a single failure in the power or control system. Such means are to provide

controlled slewing of the crane and lowering and stopping of the winch drums and cylinders under all load conditions.

8.1.7.4 Emergency Recovery System for PER++ notation

The crane is to be fitted with its own independent means for performing all main functions, such as slewing, luffing up and down, hoisting up and down, folding and unfolding, telescoping in and out, etc., in the event of a single failure in the power or control system, under all load conditions.

8.1.7.5 System Requirements

8.1.7.5.1 For the above emergency recovery systems, the following apply:

.1 Components that are used only for transfer of power or signals from the power unit to the actuators (motors, cylinders, etc.), such as pipes, flexible hoses and electric cables, need not to be taken into consideration in the single failure of the power and control system.

.2 When the crane is fitted with a secondary power and/or independent control system, the manual activation switches or handles for the emergency operation system are to be of a “hold to run type” and clearly and permanently marked for their purpose.

.3 When means for lowering are based on gravitational forces, the minimum load to enable lowering of the hook is to be determined by the manufacturer and included in the personnel lifting crane capacity rating chart.

.4 Operational instructions for the emergency recovery system are to be distinctly posted at the operator’s station.

8.1.8 Computer-based Control Systems

8.1.8.1 Where fitted, computer-based control systems of cranes intended for personnel lifting are to comply with the requirements of Part 4, Chapter 7, of the Main Rules, as applicable, for Category II Systems.

8.2 Subsea Lifting

8.2.1 General

8.2.1.1 This Subsection covers the subsea lifting of unmanned objects (non-personnel rated loads) by offshore or heavy lift cranes, excluding launch and recovery systems.

For launch and recovery systems, refer to the Part 5, Chapter 26 of the Main Rules.

8.2.1.2 Subsea lifting refers to the operation of a crane in which a load is lowered through the splash zone into the water column and is either held at an intermediate level, lowered to or released on the seabed, or is retrieved back to the vessel/unit.

8.2.1.3 Offshore and heavy lift cranes intended for subsea lifting are to meet the requirements of this section as well as the applicable in-air requirements of this document for offshore cranes or heavy lift cranes.

8.2.2 In-air Lifting

8.2.2.1 The crane structure, machinery, piping, electrical and control systems are to be designed, fabricated and tested to comply with the requirements of this document for offshore or heavy lift cranes, as applicable.

8.2.3 Subsea Lifting

8.2.3.1 In addition to the requirements of 7.2.2 above for in-air lifting, the following requirements are to be met for subsea lifting:

8.2.3.1.1 Design

.1 The manufacturer/operator is to specify the following design/operational parameters for subsea lifting:

a) Safe working load(s)
b) Rated vertical depth (maximum vertical lowering depth) of the load
c) Maximum off lead and side lead angles
d) Maximum heel and trim angles
e) Load geometry (maximum anticipated dimensions)
f) Worst case environmental conditions for operation (such as the sea state, significant wave heights, current speeds, temperature, etc.)
g) Any specific operational restrictions for equipment such as motion compensation systems
h) Mooring or dynamic positioning requirements for the vessel/offshore facility from which the subsea lifting is carried out

.2 For subsea lifting, the design of the crane is to be based on the worst case anticipated operating conditions and as a minimum, is to take into consideration the following:

a) Dynamic forces at the boom tip due to motion of the vessel and the subsea load
b) Splash zone loads (e.g., slamming loads)
c) Weight of the fully extended rope (up to the maximum lowering depth) and loose gear items
d) Added mass
e) Buoyancy
f) Current speeds
g) Drag
h) Entrained water/mud within the load
i) Seabed suction (for cases where the load is lifted from the seabed)

.3 For cranes used for occasional subsea lifting under mild environmental conditions (i.e., significant wave heights not exceeding 2m), as an alternative to .2 above, the design is to be based on a dynamic amplification factor (DAF) of not less than 2.0, an off-lead angle of not less than 5 deg. and a side-lead angle of not less than 5 deg., all acting simultaneously at the boom tip.

.4 For subsea lifting, amplified/shock loading under the following conditions are to be also taken into consideration. Alternatively, suitable means are to be provided to mitigate this loading:

a) Snap loading due to poor synchronization between the heaving motion of the subsea load versus the heaving motion of the vessel.
b) Resonance when the frequency of the vessel/wave motion matches the natural frequency of the hoisting system.

.5 When heave compensation systems are installed, the following are to be taken into consideration:

a) If the heave compensated condition is used to improve the load rating of the crane, then, the potential for shock loading and/or additional structural loading due to heave compensation system failure or synchronization issues are to be also addressed in the design.
b) In general, heave compensation systems will subject crane components (such as the running ropes, sheaves, etc.) to higher fatigue cycles over the lifetime of the crane. Where applicable, this is to be addressed in the design.

.6 For subsea lifting, the factors of safety for the design are to be in accordance with Section 2 of this document for offshore or heavy lift cranes, as applicable.

8.2.3.1.2 Load Charts for Subsea Lifting

.1 Load charts for subsea lifting are to be prepared and submitted for review. These are to be based on the design considerations under 8.2.3.1.1 above. The subsea lifting rated loads are not to exceed the respective rated loads of the in-air load charts.

8.2.3.1.3 Corrosion

.1 Crane components (e.g., sheaves, winch drums, etc.) that are in direct contact with the running ropes used for subsea lifting are to be fabricated from corrosion resistant materials, in order to protect these components from the corrosive effects of salt water carried by the ropes. Alternatively, consideration is to be given to providing means of corrosion control for these components.

8.2.3.1.4 Machinery and Systems

For subsea lifting, the crane machinery and systems are to meet the following requirements in addition to Section 5 and 6 of these Guidelines.

.1 Load Hoisting Winches

i) Load hoisting winches of the single drum type or traction/capstan and storage type may be used for subsea lifting.

ii) The winch manufacturer is to demonstrate that the design of the winch is suitable for subsea lifting. The design is to take into consideration the unique aspects associated with subsea lifting, such as increased loading on winch drums and flanges due to multilayer spooling of ropes.

iii) Single drums or storage drums are to be designed for accommodating the full length of rope that is required for subsea lifting.

iv) When single drum winches are intended for retrieval of an empty hook (after releasing the subsea load), then for synthetic fiber ropes, appropriate means are to be provided for tensioning the rope while spooling it on the drum.

.2 Control Systems, Computer-based Control Systems

When computer-based control systems are used for subsea lifting, they are to comply with the requirements of Part 4, Chapter 7, (and the sections referenced therein) of the Main Rules, as applicable, for Category I Systems.

.3 Emergency Recovery

The crane is to be fitted with an emergency means to recover the load from any operational position, in the event of a single failure in the power or control systems. As an alternative, a secondary power supply source and an independent control system for facilitating crane emergency functions may be provided for recovering the load from any operational position. An instruction plate giving detailed instructions for emergency recovery is to be provided at the crane operator's control station.

8.2.3.1.5 Motion Compensation

When motion compensation systems are installed, they are to comply with the requirements of 6.4.

When rope tensioning systems are installed, they are to comply with the requirements of 6.5.

8.2.3.1.6 Equipment

For subsea lifting, the following equipment is to be provided:

- Means for monitoring the length of running rope paid-out by load hoisting winches
- Means for monitoring the vertical depth of the load from the surface

Note: For subsea lifting, the above specified parameters need to be independently monitored by the operator in order to confirm that there is no significant rope stretch / elongation.

8.2.3.1.7 Ropes for Subsea Lifting

.1 Wire Ropes

Wire ropes are to meet the following requirements in addition to the applicable requirements of Section 2.

The factors of safety of wire ropes are to be as per 4.1.2.1.1.3 for offshore cranes or 4.1.2.1.1.2 for heavy-lift cranes, as applicable.

.2 Synthetic Fiber Ropes

The use of synthetic fiber ropes for subsea lifting will be subject to special consideration based on submission of detailed supporting documentation that demonstrates suitability of the ropes for the intended application. As a minimum, the supporting documentation is to address the time, temperature and tension characteristics of the ropes over their anticipated service life.

For the main and auxiliary hoist, the breaking strength of running ropes is not to be less than the maximum calculated tension in the rope multiplied by a minimum factor of safety of 7.

.3 Running Rope Maintenance and Inspection Schedule

The crane owner or operator is to establish and document a rope maintenance and inspection schedule for running ropes used for subsea lifting.

8.2.3.1.8 Testing

For subsea lifting, the crane is to meet the following testing requirements in addition to Section 7:

.1 Functional Testing

After installation on the vessel/unit, the crane is to be functionally tested to the satisfaction of the Surveyor and in accordance with the crane manufacturer's recommendations. This functional testing is to be carried out during the initial survey as well as the subsequent periodical surveys.
Functional testing is to include lowering the safe working load (SWL) to the rated vertical depth (of the crane for subsea lifting) and retrieval of the SWL from the rated vertical depth. Where this is not practicable, consideration may be given to the following on a case-by-case basis:

i) Lowering of the SWL to the maximum available water depth in the vicinity of the vessel/ unit's location or
ii) Simulated test using a constant tension winch or traction winch to replicate the SWL.

Functional testing is to also include verification of the rope spooling capability of the load hoisting winch, when there is no load on the hook.

.2 Hook and Block Examination

For hook and block examination requirements, refer section 7.5.

8.2.3.1.9 Subsea Lifting Certification

Certification of the crane for subsea lifting is limited to the design/operating parameters specified by the manufacturer/operator under 8.2.3.1.1.1 above.

It is the responsibility of the owner/operator to ensure that these parameters are not exceeded during subsea lifting operations.

8.2.4 Position Keeping for Support Vessels/Offshore Facilities

Support vessels/offshore facilities used for subsea lifting are to be capable of maintaining their positions safely during subsea lifting operations. The means to maintain position may be a mooring system with anchors or a dynamic positioning system.

End of the Guidelines